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INTERIM

NASA SPACE FLIGHT PROGRAM AND

PROJECT MANAGEMENT HANDBOOK

Office of the Chief Engineer

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Preface

This document is an interim placeholder while the *NASA Space Flight Program and Project Management Handbook* is being developed to provide guidance to implement the requirements of NASA Policy Directive (NPR) 7120.5E. The *NASA Space Flight Program and Project Management Handbook* describes how programs and projects are managed at NASA and contains explanatory material to help understand the requirements of NPR 7120.5E.

Key Policy Changes in 7120.5

This handbook reflects key policy changes in space flight program and project management implemented with the NPR 7120.5E. The Agency is focusing resources and emphasizing program and project activities during the Formulation Phase of the life cycle. This focus is needed to accurately characterize the complexity and scope of the project; increase understanding of programmatic requirements; and identify and mitigate high technical, acquisition, cost, and schedule risks to improve the fidelity and realism of project cost and schedule commitments made at Implementation. Policy changes also reflect an expanded role for Center Directors and strengthening the elements of governance, which includes the independent role of Technical Authority (TA). To support these policy changes, NPR 7120.5 defined a new structure for formulating, baselining, and rebaselining (if necessary) the agreements that set the parameters within which programs and projects work. These concepts are explained in more detail in this handbook. Additional details are provided on the estimates, probabilistic assessments, and confidence levels leading to the formal Joint Cost and Schedule Confidence Level (JCL) at Implementation and on Earned Value Management (EVM) as it applies at NASA. The life cycles of the three types of program and projects have been refined and are explained in more detail in Chapter 2, clarifying the reviews leading to KDP E and describing the decommissioning review. Additionally, this handbook describes elements of program and project plans, such as the requirement to perform space system threat assessments.

Chapter 1. Introduction

1.1 Purpose

1.1.1 This document supports the implementation of the requirements by which NASA formulates and implements space flight programs and projects as published in NPR 7120.5E. This handbook contains context, detail, rationale, and guidance that supplements and enhances the understanding of the high-level policy document.

1.2 Document Structure

1.2.1 This document is organized with Chapter 1 providing an overview of the NASA governance and strategic management policies that form the foundation for program and project management. Chapter 2 defines the different types of programs and projects, their documentation, and how the different types of programs and projects mature through their life cycle. It also describes how to establish baselines and approval processes. Chapter 3 describes roles and responsibilities relevant to program and project managers, the governance structure, Technical Authority, the Dissenting Opinion process, and how to tailor requirements. Chapter 4 explains the management requirements for programs and projects by life cycle phase and specifies the milestone products and control plans required in each phase. Appendix C contains the Work Breakdown Structure (WBS). Review processes for launch and decommissioning are illustrated in appendices D and G, respectively. Appendix E contains a template for the Decision memorandum. Other templates examples, frequently asked questions, and further guidance supporting NPR 7120.5E requirements can be found on the NASA Engineering Network (NEN) Web site at https://nen.nasa.gov/web/pm.[1] Tables of detailing the expected maturity for different program types and projects as they move through their life cyle phases are contained in Appendix F.

1.3 Background

1.3.1 NASA space flight programs and projects develop and operate a wide variety of spacecraft, launch vehicles, in-space facilities, communications networks, instruments, and supporting ground systems.[2] This document establishes a standard of uniformity for the process by which NASA formulates and implements space flight programs and projects consistent with the governance model contained in NASA Policy Directive (NPD) 1000.0, *NASA Governance and Strategic Management Handbook*. The governance model provides an organizational structure that emphasizes mission success by balancing different perspectives from different elements of the organization. The organizational separation of the Mission Directorates and their respective programs and projects (Programmatic Authorities) from the Headquarters Mission Support Offices, the Center organizations that are aligned with these Mission Support Offices, and the Center Directors (Institutional Authorities) is the cornerstone of this organizational

[1] The NASA Engineering Network Web site also provides the list of NASA programs and projects from the Meta-Data Manager (MDM) and links to general information useful to program and project managers.

[2] NASA space flight programs and projects often need to mature technologies to meet mission goals. These enabling and/or enhancing technologies are also covered by NPR 7120.5.

structure and NASA's system of checks and balances. NASA governance and core values support the expectation that Programmatic and Institutional Authorities together support the success of the Agency's mission portfolio while maintaining the capability needed to support the Agency's long-term strategic goals.

The separation of authorities is illustrated in Figure 1-1.

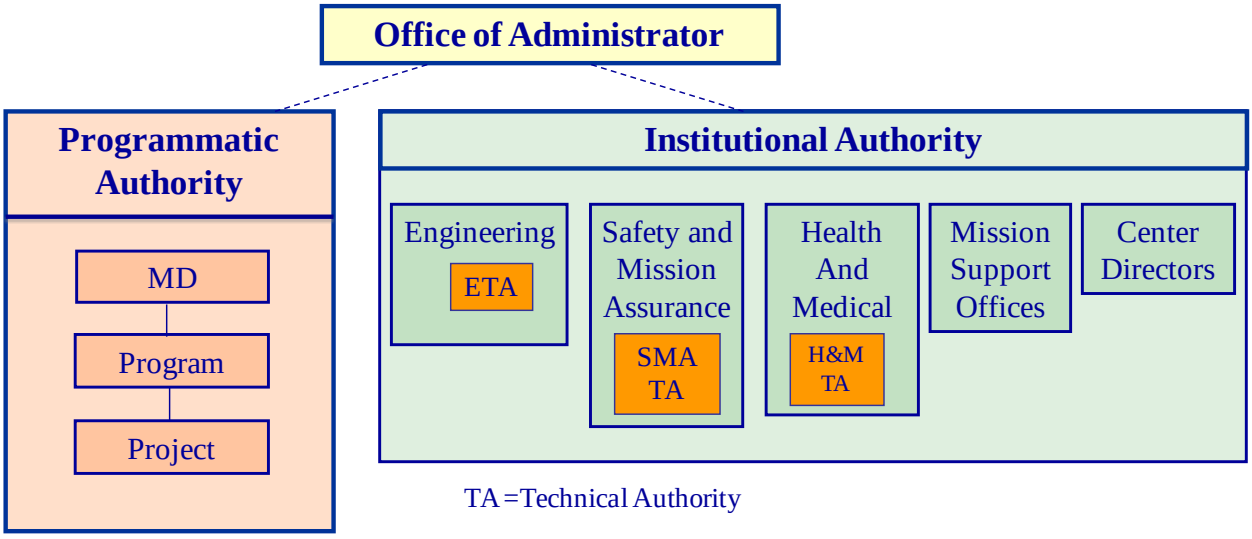


Figure 1-1 Separation of Programmatic and Institutional Authority

1.3.2 Programmatic Authority resides with the Mission Directorates and their respective programs and projects. It is largely described in Sections 3.1 and 3.3 by the roles and responsibilities of the NASA Associate Administrator (AA), Mission Directorate Associate Administrators (MDAAs), and program and project managers.

1.3.3 The Institutional Authority (described in Section 3.4) encompasses all those organizations not in the Programmatic Authority. Engineering, Safety and Mission Assurance, and Health and Medical organizations are a unique segment of the Institutional Authority. They support programs and projects in two ways:

a. They provide technical personnel and support and oversee the technical work of personnel who provide the technical expertise to accomplish the program or project mission.

b. They provide Technical Authorities, who independently oversee programs and projects. These individuals have a formally delegated Technical Authority role traceable to the Administrator and are funded independent of programs and projects. The Technical Authorities are described in Section 3.5.

1.3.4 Well-trained and experienced program and project managers are essential to the successful accomplishment of NASA's overall mission as well as to the success of individual programs and projects. NASA has an Agency-wide career development framework and program that provides a roadmap for career training and development and for meeting the Agency's current and future

demands for program and project managers. This framework is in compliance with Office of Management and Budget's (OMB) Federal acquisition program/project management certification requirements. The development framework is defined in the *Project Management and Systems Engineering Competency Framework.* The *Federal Acquisition Certification for Program/Project Managers: Guidelines for Certifying Senior/Expert Level NASA P/PM's* describes the process and requirements for certification at NASA. Certification is required for individuals who manage programs or projects with a life cycle cost greater than $250 million.

1.3.5 Central to the program and project management process are the program and project life cycles and the Key Decision Points (KDPs) within these life cycles. This document also outlines program/project decision processes and summarizes the roles and responsibilities of key personnel involved in NASA program and project management: the Agency Program Management Council (APMC), the Mission Directorates, the Centers,[3] program managers, and project managers. It further identifies and summarizes the Technical Authority process as it applies to space flight program and project management[4] and codifies the top-level management requirements for safe and successful program or project Formulation and Implementation.

1.3.6 This document distinguishes between "programmatic requirements" and "institutional requirements." Both categories of requirements ultimately need to be satisfied in program and project Formulation and Implementation. Programmatic requirements are the responsibility of the Programmatic Authorities and focus on the products to be developed and delivered and specifically relate to the goals and objectives of a particular NASA program or project. These programmatic requirements flow down from the Agency's strategic planning process. Table 1-1 shows this flow down from Agency strategic planning through Agency, directorate, program, and project requirements levels to the systems that will be implemented to achieve the Agency goals.

[3] The term "Center" here and throughout this document is meant to include NASA Component Facilities, Technical and Service Support Centers (per NPD 1000.3), and the Jet Propulsion Laboratory (JPL).

[4] The establishment of a technical authority process represents a direct response to the Columbia Accident Investigation Board (CAIB) recommendations—specifically, CAIB recommendation R7.5-1.

Table 1-1 Programmatic Requirements Hierarchy

Requirements Level	Content	Governing Document	Approver	Originator
Strategic Goals	Agency strategic direction	NPD 1000.0, *NASA Governance and Strategic Management Handbook*; NPD 1001.0; *NASA Strategic Plan;* and Strategic Planning Guidance	NASA Administrator	Support Organizations
Agency Requirements	Structure, relationships, principles governing design and evolution of cross-Agency Mission Directorate systems linked in accomplishing Agency strategic goals and outcomes	Architectural Control Document (ACD)	NASA Administrator	Host MDAA with Inputs from Other Affected MDAAs
Mission Directorate Requirements	High-level requirements levied on a program to carry out strategic and architectural direction including programmatic direction for initiating specific projects	Program Commitment Agreement (PCA)	NASA AA	MDAA
Program Requirements	Detailed requirements levied on a program to implement the PCA and high-level programmatic requirements allocated from the program to its projects	Program Plan	MDAA	Program Manager
Project Requirements	Detailed requirements levied on a project to implement the Program Plan and flow down programmatic requirements allocated from the program to the project	Project Plan	Program Manager	Project Manager
System Requirements	Detailed requirements allocated from the project to the next lower level of the project	System Requirements Documentation	Project Manager	Responsible System Lead

MDAA = Mission Directorate Associate Administrator; NASA AA = NASA Associate Administrator

1.3.7 Institutional requirements are the responsibility of the Institutional Authorities. See Section 3.5 for details on Technical Authority. They focus on how NASA does business and are

independent of any particular program or project. These requirements are issued by NASA Headquarters (including the Office of the Administrator, Mission Directorates, and Mission Support Offices) and by Center organizations. Institutional requirements may respond to Federal statute, regulation, treaty, or Executive Order. They are normally documented in the following:

a. **NASA Policy Directives** (NPDs)—Agency policy statements that describe what is required by NASA management to achieve NASA's vision, mission, and external mandates and describe who is responsible for carrying out those requirements.

b. **NASA Procedural Requirements** (NPRs)—NPRs provide Agency-mandatory requirements to implement NASA policy as delineated in an associated NPD.

c. **NASA Standards**—Formal documents that establish a norm, requirement, or basis for comparison, a reference point to measure or evaluate against. A technical standard, for example, establishes uniform engineering or technical criteria, methods, processes, and practices. NASA standards include Agency-level standards as well as Center-level standards.

d. **Center Policy Directives** (CPDs)—CPDs define Center-specific policy requirements and responsibilities that apply only to the issuing Center and operations performed by NASA personnel at that Center (and must comply with requirements delineated in associated NPDs and NPRs).

e. **Center Procedural Requirements** (CPRs)—CPRs establish Center-specific procedural requirements and responsibilities to implement the policies and procedural requirements defined in related NPDs, NPRs, or CPDs. CPRs apply only to the issuing Center and operations performed by NASA personnel at that Center.

f. **Mission Directorate Requirements**—Mission Directorate requirements contained in Mission Directorate documentation apply to activities, products, or services supporting program and project office needs, which could extend across multiple Centers.

1.3.8 NASA's updated program and project management policy is part of a realignment of governing documents within NASA designed to increase accountability and general clarity in the flow down of both programmatic and institutional requirements. NASA's updated program and project management policy is also focused on improving program and project performance against internal and external commitments. Figure 1-2 shows flow down from NPD 1000.0 through Program and Project Plans. The figure identifies the five types of institutional requirements that flow down to these plans: engineering, program/project management, safety and mission assurance, health and medical, and Mission Support Office (MSO) functional requirements. These terms are defined in Appendix A.

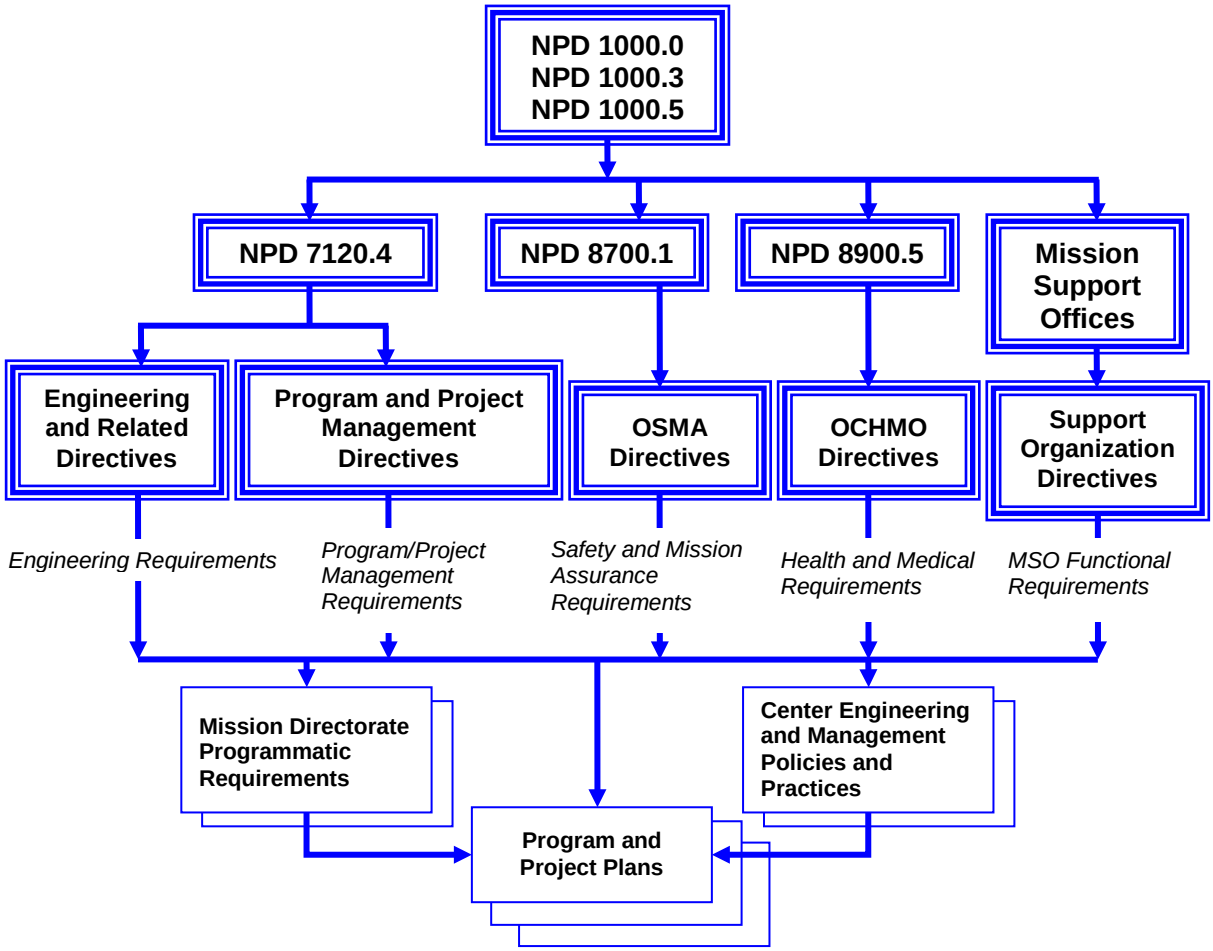


Figure 1-2 Institutional Requirements Flow Down

1.4 Overview of Management Process

1.4.1 Although this document emphasizes program and project management based on life cycles, Key Decision Points (KDPs), and evolving products during each life cycle phase, these are embedded in NASA's four-part process for managing programs and projects, which consists of:

a. **Formulation**— identifying how the program or project supports the Agency's strategic goals; assessing feasibility, technology, concepts, and performance of trade studies; risk assessment and possible risk mitigations based on risk-informed decision making (RIDM) and continuous risk management (CRM) processes; team building; developing operations concepts and acquisition strategies; establishing high-level requirements, requirements flow down, and success criteria; assessing the relevant industrial base/supply chain to ensure the program or project success; preparing plans, cost estimates, budget submissions, and schedules essential to the success of a program or project; and establishing control systems to ensure performance of those plans and alignment with current Agency strategies.

b. **Approval** (for Implementation)—acknowledgment by the Decision Authority (see Appendix A for definition of "Decision Authority") that the program or project has met Formulation requirements and is ready to proceed to Implementation. By approving a program/project, the Decision Authority commits to the time-phased cost plan based on technical scope and schedule necessary to continue into Implementation.

c. **Implementation**—execution of approved plans for the development and operation of the program/project, and use of control systems to ensure performance to approved plans and requirements and continued alignment with the Agency's strategic goals.

d. **Evaluation**—the continual self- and independent assessment of the performance of a program or project and incorporation of the assessment findings to ensure adequacy of planning and execution according to approved plans and requirements.

1.4.2 NASA's core values,[5] illustrated in Figure 1-3, form the foundation for the program and project management process. NASA's core values guide all parties to constructively engage as partners and to strive to resolve issues at the lowest possible level. These values are:

a. **Safety**—NASA's constant attention to safety is the cornerstone upon which we build mission success. We are committed, individually and as a team, to protecting the safety and health of the public, our team members, and those assets that the Nation entrusts to the Agency.

b. **Integrity**—NASA is committed to maintaining an environment of trust, built upon honesty, ethical behavior, respect, and candor. Our leaders enable this environment by encouraging and rewarding a vigorous, open flow of communication on all issues, in all directions, and among all employees without fear of reprisal. Building trust through ethical conduct as individuals and as an organization is a necessary component of mission success.

c. **Teamwork**—NASA's most powerful tool for achieving mission success is a multi-disciplinary team of diverse competent people across all NASA Centers. Our approach to teamwork is based on a philosophy that each team member brings unique experience and important expertise to project issues. Recognition of and openness to that insight improves the likelihood of identifying and resolving challenges to safety and mission success. We are committed to creating an environment that fosters teamwork and processes that support equal opportunity, collaboration, continuous learning, and openness to innovation and new ideas.

d. **Excellence**—To achieve the highest standards in engineering, research, operations, and management in support of mission success, NASA is committed to nurturing an organizational culture in which individuals make full use of their time, talent, and opportunities to pursue excellence in both the ordinary and the extraordinary.

[5] Quoted from NPD 1000.0, *NASA Governance and Strategic Management Handbook*.

NASA is committed to a core set of values in everything it does. Mission success requires uncompromising commitment to Safety, Integrity, Teamwork, and Excellence

Figure 1-3 NASA Core Values

1.5 Acquisition and Partnering

1.5.1 NASA's program and project support of its overall mission is long term in nature, but the environments in which these programs and projects are conducted are dynamic. In recognition of this, NPD 1000.0, *NASA Governance and Strategic Management Handbook* and NPD 1000.5, *Policy for NASA Acquisitions* have put in place a framework for ensuring that NASA's strategic vision, programs and projects, and resources remain properly aligned. The acquisition and partnering process and annual strategic resource planning form a continuous process to oversee this alignment. At the program and project level, the Acquisition Strategy Meeting (ASM) and the Procurement Strategy Meeting (PSM) support the Agency's acquisition process, which includes strategic planning as well as procurement.

1.5.2 **The Acquisition Strategy Meeting (ASM)—**Before authorizing resource expenditures for major acquisitions, the acquisition strategy is reviewed and agreed upon by senior Agency management. This includes implementation of the decisions and guidance that flowed out of the Agency strategic planning and consideration of resource availability, impact on the Agency workforce, maintaining core capabilities, make-or-buy planning, supporting Center assignments, and the potential for partnerships. The development of an acquisition strategy also includes an analysis of the industrial base capability to design, develop, produce, support, if appropriate, restart an acquisition program or project as well as the mechanisms used to identify, monitor, and mitigate industrial base and supply chain risks. This is generally accomplished with an ASM review chaired by the Administrator (or designee), based on information provided by the associated Mission Directorate or Mission Support Office, and results in approval of plans for Formulation and Implementation. Decisions are documented in the ASM meeting minutes.

1.5.3 **The Procurement Strategy Meeting (PSM)**—Procurement regulations (the Federal Acquisition Regulation (FAR) and NASA FAR Supplement (NFS)) require specific activities and decisions to be addressed and documented as part of the acquisition planning process for individual procurements. For major and other selected procurements, this is accomplished at a PSM, chaired by the Assistant Administrator for Procurement (or designee) and is based on information provided by the associated program or project. In addition to the information

required by the FAR and the NFS, the PSM should incorporate the strategic guidance and confirm the decisions of the ASM. Decisions are documented in the PSM meeting minutes.

Chapter 2. NASA Life Cycles for Space Flight Programs and Projects

2.1 Programs and Projects

2.1.1 Space flight programs and projects are often the most visible and complex of NASA's strategic investments. These programs and projects flow from the implementation of national priorities, defined in the Agency's Strategic Plan, through the Agency's Mission Directorates as part of the Agency's general work breakdown hierarchy shown in Figure 2-1.

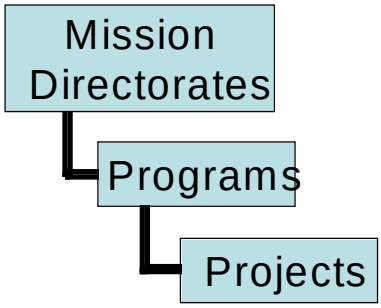


Figure 2-1 Programmatic Authority Organizational Hierarchy

2.1.2 This hierarchical relationship of programs to projects shows that programs and projects are different and their management involves different activities and focus. The following definitions are used to distinguish the two:

a. **Program**—a strategic investment by a Mission Directorate or Mission Support Office that has a defined architecture, and/or technical approach, requirements, funding level, and a management structure that initiates and directs one or more projects. A *program* implements a strategic direction that the Agency has identified as needed to accomplish Agency goals and objectives.

b. **Project**—a specific investment identified in a Program Plan having defined requirements, a life cycle cost, a beginning, and an end. A project also has a management structure and may have interfaces to other projects, agencies, and International Partners. A project yields new or revised products that directly address NASA's strategic goals.

c. Regardless of the structure of a program or project categorized as a space flight program or project, NPR 7120.5 applies to the full scope of the program or project and all the activities under it. Specific NPR 7120.5 requirements are flowed down to these activities to the extent necessary for the program or project to ensure compliance and mission success. See Section 3.7 for the process of obtaining any required deviations or waivers.

2.1.3 NASA Programs

2.1.3.1 NASA space flight programs are initiated and implemented to accomplish scientific or exploration goals that generally require a collection of mutually supporting projects. Programs integrate and manage these projects over time and provide ongoing enabling systems, activities, methods, technology developments, and feedback to projects and stakeholders. Programs are generally created by a Mission Directorate with a long-term time horizon in mind, though as the Agency's strategic direction or circumstances change, a Mission Directorate occasionally needs to replan its programs or combine related programs to increase effectiveness. Programs are generally executed at NASA Centers under the direction of the Mission Directorate and are assigned to Centers based on decisions made by Agency senior management consistent with the results of the Agency's strategic acquisition planning process. Because the scientific and exploration goals of programs vary significantly, different program implementation strategies are required, ranging from very simple to very complex. To accommodate these differences, NASA identifies four basic types of programs (defined in Appendix A) that may be employed:

a. **Single project programs** tend to have long development and/or operational lifetimes, represent a large investment of Agency resources in one program or project, and have contributions to that program/project from multiple organizations or agencies.

b. **Uncoupled programs** (e.g., Discovery Program) are implemented under a broad theme and/or a common program implementation concept, such as providing frequent flight opportunities for cost-capped projects selected through Announcements of Opportunity (AO) or NASA Research Announcements (NRA). Each such project is independent of the other projects within the program.

c. **Loosely coupled programs** (e.g., Mars Exploration Program) address specific objectives through multiple space flight projects of varied scope. While each individual project has an assigned set of mission objectives, architectural and technological synergies and strategies that benefit the program as a whole are explored during the formulation process. For instance, Mars orbiters designed for more than one Mars year in orbit are required to carry a communication system to support present and future landers.

d. **Tightly coupled programs** have multiple projects that execute portions of a mission or missions. No single project is capable of implementing a complete mission. Typically, multiple NASA Centers contribute to the program. Individual projects may be managed at different Centers. The program may also include other agency or International Partner contributions.

2.1.4 NASA Projects

2.1.4.1 As with programs, projects vary in scope and complexity and, thus, require varying levels of management requirements and Agency attention and oversight. Consequently, project categorization defines Agency expectations of project managers by determining both the oversight council and the specific approval requirements. Projects are Category 1, 2, or 3 and are assigned to a category based initially on: (1) the project life cycle cost (LCC) estimate, the

inclusion of significant radioactive material[6], and whether the system being developed is for human space flight; and (2) the priority level, which is related to the importance of the activity to NASA, the extent of international participation (or joint effort with other government agencies), the degree of uncertainty surrounding the application of new or untested technologies, and spacecraft/payload development risk classification. (See NPR 8705.4, *Risk Classification for NASA Payloads.*) Guidelines for determining project categorization are shown in Table 2-1, but categorization may be changed based on recommendations by the Mission Directorate Associate Administrator (MDAA) that consider additional risk factors facing the project. The NASA Associate Administrator (AA) approves the final project categorization. The Office of the Chief Engineer (OCE) is responsible for the official listing of NASA programs and projects subject to NPD 7120.4, *NASA Engineering and Program/Project Management Policy*.[7] For purposes of project categorization, the project life cycle cost estimate includes phases A through F and all Work Breakdown Structure (WBS) Level 2 elements (see Appendix C), and is measured in real year (nominal) dollars.

Table 2-1 Project Categorization Guidelines

Priority Level	LCC < $250M	$250M ≤ LCC ≤ $1B	LCC > $1B, significant radioactive material, or human space flight
High	Category 2	Category 2	Category 1
Medium	Category 3	Category 2	Category 1
Low	Category 3	Category 2	Category 1

2.1.4.2 When projects are initiated, they are assigned to a NASA Center or implementing organization by the MDAA consistent with direction and guidance from the strategic acquisition planning process. They are either assigned directly to a Center by the Mission Directorate or are selected through a competitive process, such as an Announcement of Opportunity (AO).[8] For Category 1 projects, the assignment is with the concurrence of the NASA AA.

2.1.5 Figure 2-2 is a summary of the NASA life cycles for space flight programs and projects and provides an overview of their interrelated life cycle management processes with pointers for key events to sections in this document where more information is provided.

[6] Nuclear safety launch approval is required by the Administrator or Executive Office of the President when significant radioactive materials are included onboard the spacecraft and/or launch vehicle. (Levels are defined in NPR 8715.3, *NASA General Safety Program Requirements*.)

[7] This data is maintained by the Office of Chief Financial Officer in a database called the Meta-Data Manager (MdM). This database is the basis for the Agency's work breakdown and forms the structure for program and project status reporting across all Mission Directorates and Mission Support Offices.

[8] As part of the process of assigning projects to NASA Centers, the affected program manager may recommend project assignments to the MDAA.

2.2 Program and Project Life Cycles

2.2.1 Programs and projects follow their appropriate life cycle, which includes life cycle phases; life cycle gates and major events, including KDPs; major life cycle reviews (LCRs); principal documents that govern the conduct of each phase; and the process of recycling through Formulation when program changes warrant such action.

2.2.2 As a strategic management structure, the program construct is extremely important within NASA. Programs provide the critically important linkage between the Agency's strategic goals and the projects that are the specific means for achieving them. Although programs vary significantly in scope, complexity, cost, and criticality, within NASA they have a common life cycle management process that is divided into two distinct phases:

a. **Formulation**—Pre-Program Acquisition, during which a technical approach is derived from an analysis of alternatives; program requirements are developed and allocated to initial projects; project pre-Formulation is initiated; organizational structures are developed and work assignments initiated; program acquisition strategies are defined and approved; interfaces to other programs are developed; required annual funding levels are established, preliminary cost and schedule estimates are developed; a plan for implementation is designed, and management systems are put in place; and formal program documentation is approved, all consistent with the NASA Strategic Plan and other higher level requirements. While not part of Formulation, some Implementation activities may occur during Formulation.

b. **Implementation**—Program acquisition, operations and sustainment, during which constituent projects are initiated through direct assignment or competitive process (e.g., Request for Proposal (RFP) and AO) and their formulation, approval, implementation, integration, operation, and ultimate decommissioning are constantly monitored and the program is adjusted as resources and requirements change. For tightly coupled programs, the Implementation Phase will coincide with the project life cycle to ensure that the program and all its projects are properly integrated, including proper interface definition and resource allocation across all internal projects and with external programs and organizations. In some cases, programs may recycle through Formulation when program changes are sufficient to warrant such action.

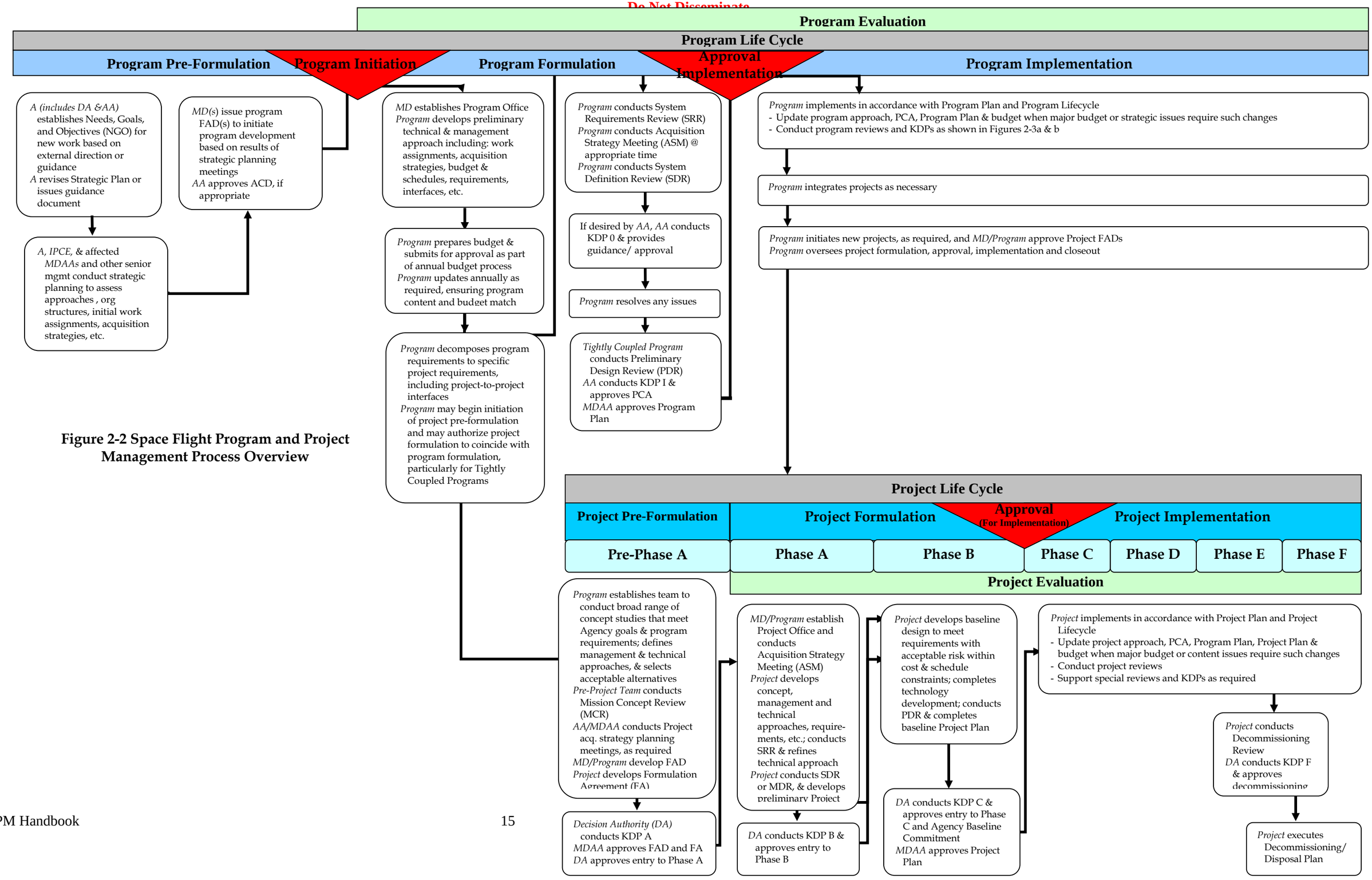


Figure 2-2 Space Flight Program and Project Management Process Overview

2.2.3 The program life cycle formalizes the management process. Programs transition from Formulation to Implementation at Key Decision Point (KDP) I. However, the attendant life cycle reviews may differ depending on the program type. For uncoupled and loosely coupled programs, the life cycle is depicted in Figure 2-3a. Figure 2-3b illustrates the life cycle for tightly coupled programs. These figures show:

a. The program life cycle phases.

b. Program life cycle gates and major events, including KDPs.

c. Major program life cycle reviews. (See Section 2.5.)

d. The process of recycling through Formulation when program changes warrant such action.

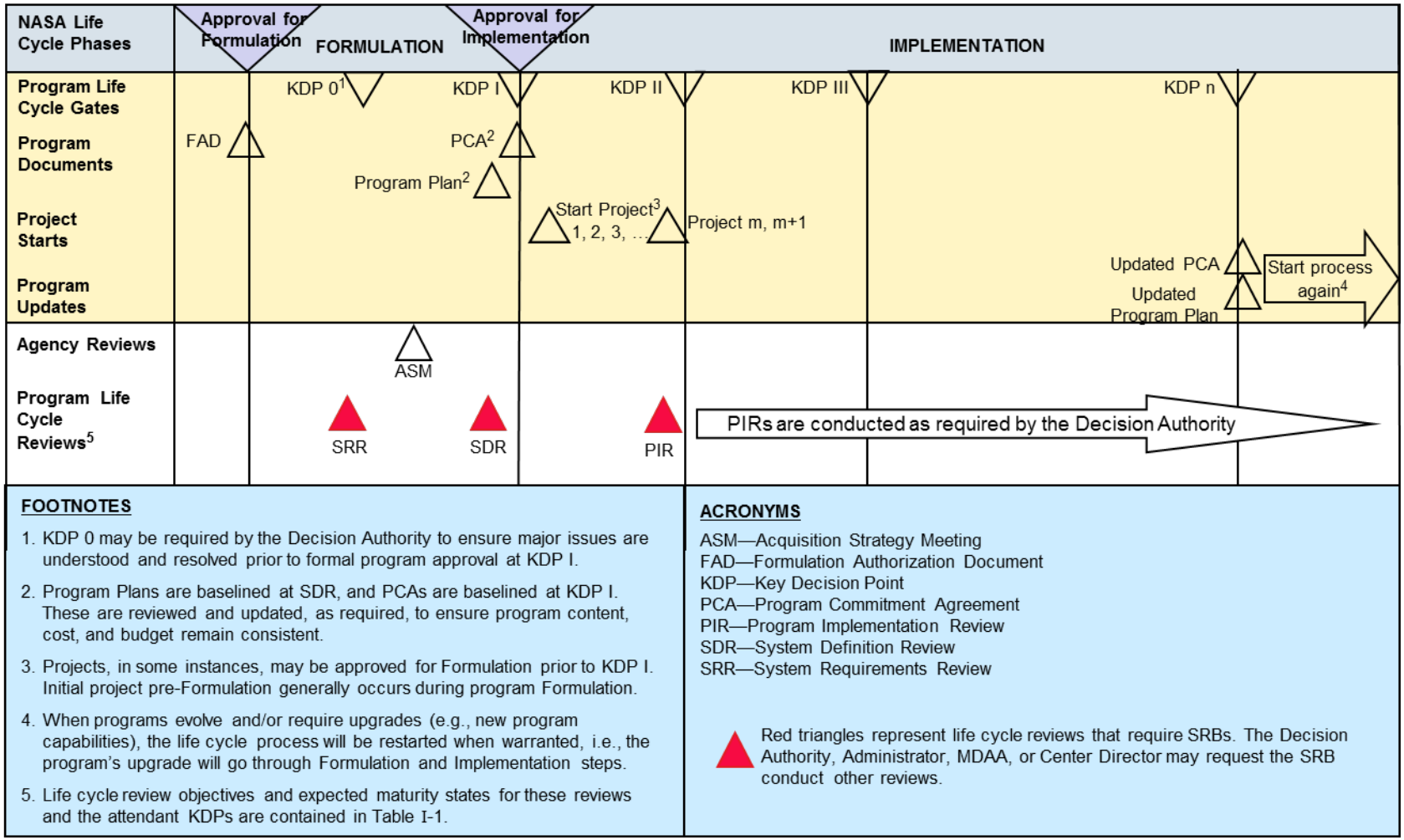
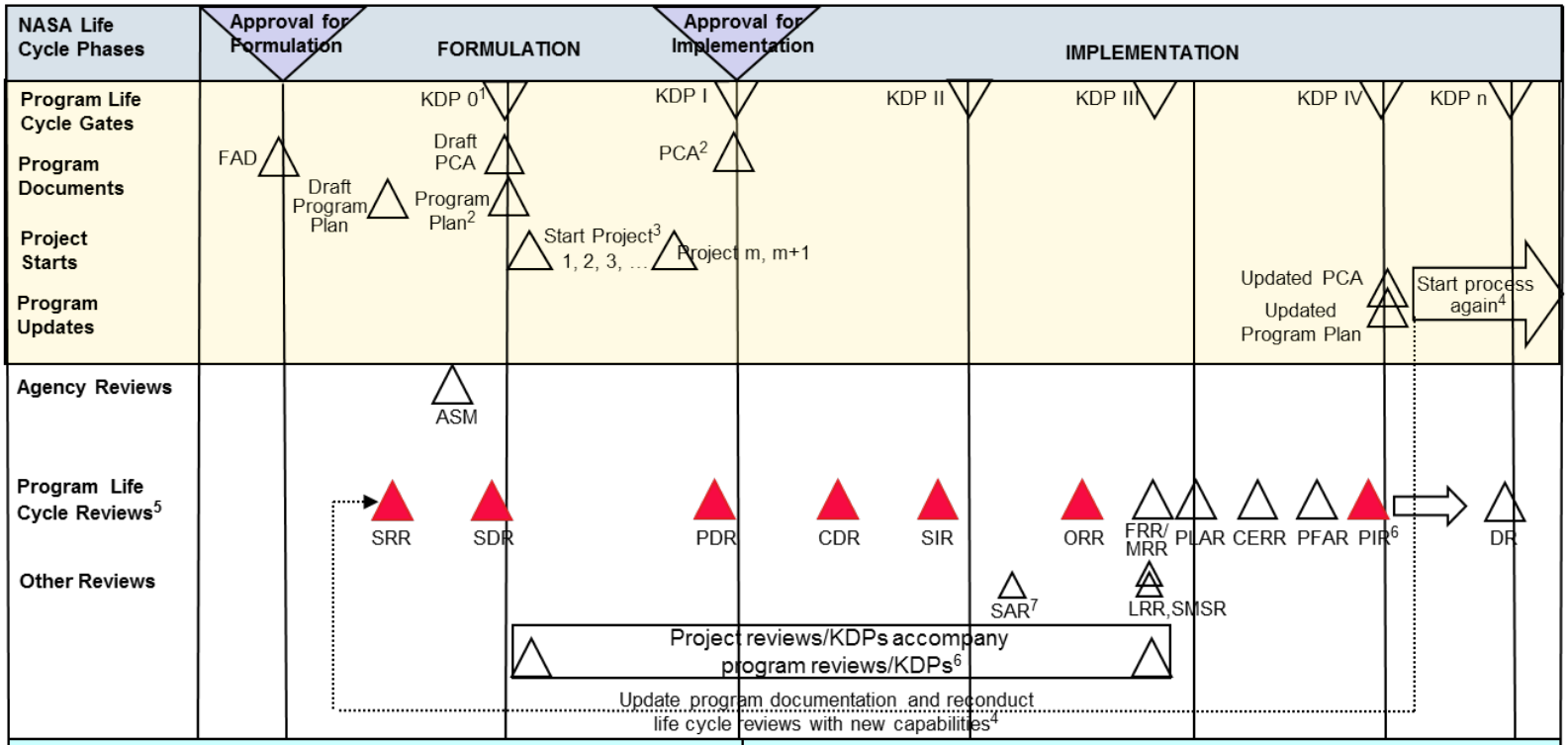


Figure 2-3a NASA Uncoupled and Loosely Coupled Program Life Cycle



FOOTNOTES

1. KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.
2. Program Plans are baselined at SDR, and PCAs are baselined at KDP I. These are reviewed and updated, as required, to ensure program content, cost, and budget remain consistent.
3. Projects are usually approved for Formulation prior to KDP I.
4. When programs evolve and/or require upgrades (e.g., new program capabilities), the life cycle process will be restarted when warranted, i.e., the program's upgrade will go through Formulation and Implementation steps.
5. Life cycle review objectives, expected maturity states for these reviews, and the attendant KDPs are contained in Table I-2.
6. Tightly coupled program reviews generally differ from the reviews of other program types because they are conducted to ensure the overall integration of all program elements (i.e., projects). Once the program is in operations, PIRs are conducted as required by the Decision Authority.
7. SAR applies only to human space flight.

ACRONYMS

ASM—Acquisition Strategy Meeting
CDR—Critical Design Review
CERR—Critical Events Readiness Review
DR—Decommissioning Review
FAD—Formulation Authorization Document
FRR—Flight Readiness Review
KDP—Key Decision Point
LRR—Launch Readiness Review
MRR—Mission Readiness Review
ORR—Operational Readiness Review
PCA—Program Commitment Agreement
PDR—Preliminary Design Review
PFAR—Post-Flight Assessment Review
PIR—Program Implementation Review
PLAR—Post-Launch Assessment Review
SAR—System Acceptance Review
SDR—Program/System Definition Review
SIR—System Integration Review
SMSR—Safety and Mission Success Review
SRB—Standing Review Board
SRR—Program/System Requirements Review

Red triangles represent life cycle reviews that require SRBs. The Decision Authority, Administrator, MDAA, or Center Director may request the SRB to conduct other reviews.

Figure 2-3b NASA Tightly Coupled Program Life Cycle

2.2.3.1 Each program life cycle phase includes one or more Life Cycle Reviews (LCRs). An LCR is a review designed to provide a periodic assessment of a program's technical and programmatic status and health at a key point in the life cycle. LCRs are essential elements of conducting, managing, evaluating, and approving space flight programs, and are an important part of NASA's system of checks and balances. LCRs are conducted by the program and project and an independent Standing Review Board (SRB) with the exceptions noted in Table 2-3. NASA accords special importance to maintaining the integrity of its independent review process. LCRs provide the program and NASA senior management with a credible, objective assessment of how the program is doing. The final LCR in a given program life cycle phase provides essential information for the KDP, which marks the end of that life cycle phase.

2.2.3.2 A KDP is an event where the Decision Authority determines the readiness of a program to progress to the next phase of the life cycle (with the exception of KDP E). As such, KDPs serve as gates through which programs must pass. The Decision Authority makes his/her decision by considering a number of factors, including technical maturity; continued relevance to Agency strategic goals; adequacy of cost and schedule estimates; associated probabilities of meeting those estimates (confidence levels); continued affordability with respect to the Agency's resources; maturity and the readiness to proceed to the next phase; and remaining program or project risk (cost, schedule, technical, management, programmatic, and safety). KDPs associated with programs are designated with Roman numerals. The first KDP is KDP 0: the second is KDP I.

2.2.3.3 The Formulation Phase for uncoupled and loosely coupled programs is completed at KDP I after the program System Definition Review (SDR). As depicted in Figure 2-3a, Program Implementation Reviews (PIRs) are conducted during the Implementation Phase for uncoupled and loosely coupled programs. The Decision Authority will determine the need for PIRs to assess the program's performance and authorize its continuation. This determination will be made on an annual basis.

2.2.3.4 Single project programs follow the project life cycle, shown in Figure 2-4, and associated project requirements, and follow the program requirements to develop a draft Program Commitment Agreement (PCA) and Program Plan, due at KDP B, with final versions approved by KDP C.

Tightly coupled programs are more complex, as shown in Figure 2-3b. Since the program is intimately tied to the projects, the Formulation Phase mirrors the project life cycle shown in Figure 2-4, and program approval (KDP I) occurs after the program-level Preliminary Design Review (PDR). Once approved, the Implementation Phase continues to have program life cycle reviews tied to the project life cycle reviews to ensure the proper integration of projects into the larger system. Once a tightly coupled program is in operation, the Decision Authority will determine the need for PIRs to assess the program's performance and authorize its continuation. This determination will be made on an annual basis.

2.2.4 Key Program Documents

2.2.4.1 Program Formulation and Implementation require the preparation and approval of three key documents—a program Formulation Authorization Document (FAD), a Program Commitment Agreement (PCA), and a Program Plan—each of which is described below.

2.2.4.2 Formulation Authorization Document

2.2.4.3 To initiate planning for individual programs, a Mission Directorate prepares a program FAD including the results of the Agency strategic acquisition planning. The program FAD authorizes a program manager to initiate the planning of a new program and to perform the analysis of alternatives required to formulate a sound Program Plan that contains project elements, requirements, schedules, and time-phased cost plans.

2.2.4.4 Because the creation of a new program represents a major commitment of the Agency and may require coordination with OMB and/or the Congress, the FAD requires the approval of the MDAA and NASA AA. At the discretion of the AA, the updated FAD can serve as the KDP 0 Decision Memorandum. The program FAD contains a statement of purpose for the proposed program and defines its relationship to the Agency's strategic goals, establishes the scope of work to be accomplished, provides initial constraints (including resources and schedule) and proposed program participants within and external to NASA (including international partnerships), and defines the approach and resources required to conduct program Formulation.

2.2.4.5 Program Commitment Agreement

2.2.4.6 The PCA is an agreement between the MDAA and the NASA AA (the Decision Authority) that authorizes program transition from Formulation to Implementation. The PCA is prepared by the Mission Directorate with support from the program manager, as requested. The PCA documents Agency requirements that flow down to the program, Mission Directorate requirements, program objectives, management and technical approach and associated architecture, technical performance, schedule, time-phased cost plans, safety and risk factors, internal and external agreements, life cycle reviews, and all attendant top-level program requirements.

2.2.4.7 A PCA can be considered an executive summary of the Program Plan and is updated and approved during the program life cycle. As a minimum, a significant change in program content, including addition or deletion of a constituent project, warrants a change in the PCA. The content of the PCA baselined at KDP I reflects the maturity of the program at that time and includes acknowledgment of those areas that cannot be defined without further development. When needed, the PCA is updated to reflect subsequent KDP decisions. The PCA must remain consistent with NASA strategic planning, Architectural Control Documents, budget authority, and other external reporting. Program and project managers support the Mission Directorate in keeping the program's current baseline cost estimates and funding strategy, the annual NASA budget submissions, and external commitments consistent.

2.2.4.8 Program Plan

2.2.4.9 The Program Plan is an agreement between the MDAA (who has final approval authority for the plan), the participating Center Director(s), and the program manager. It documents, at a high level, the program's objectives and requirements, scope, implementation approach, interfaces with other programs, environment within which the program operates, funding by time-phased cost plans consistent with the approved PCA, and commitments of the program. The Program Plan is prepared by the program manager with the support of program personnel. Implementation of a program, project, or task at a NASA Center is performed in accordance with the Program Plan and consistent with the Mission Directorate's requirements as negotiated and documented in the Program Plan and with Agency policy and the Center's best practices and institutional policies. The agreements between the program manager and Center Directors of participating NASA Centers are documented in the Program Plan along with the program manager's approach to ensuring that interfaces do not increase risk to mission success. Program Plan approval by the participating NASA Center Directors also demonstrates their commitment to support the program.

2.2.4.10 The Program Plan details how the program will be managed and contains the list of specific projects (updated, as needed) that are approved as part of the program and, therefore, which are subject to the requirements on projects in this document. The Program Plan also documents the high-level program requirements on each project, including performance, safety, and programmatic requirements correlated to Agency and Mission Directorate strategic goals and any approved tailoring of requirements. These requirements and tailoring are subsequently documented in the Program Plan, in a Program Plan appendix, or in a separate, configuration-controlled program requirements document.

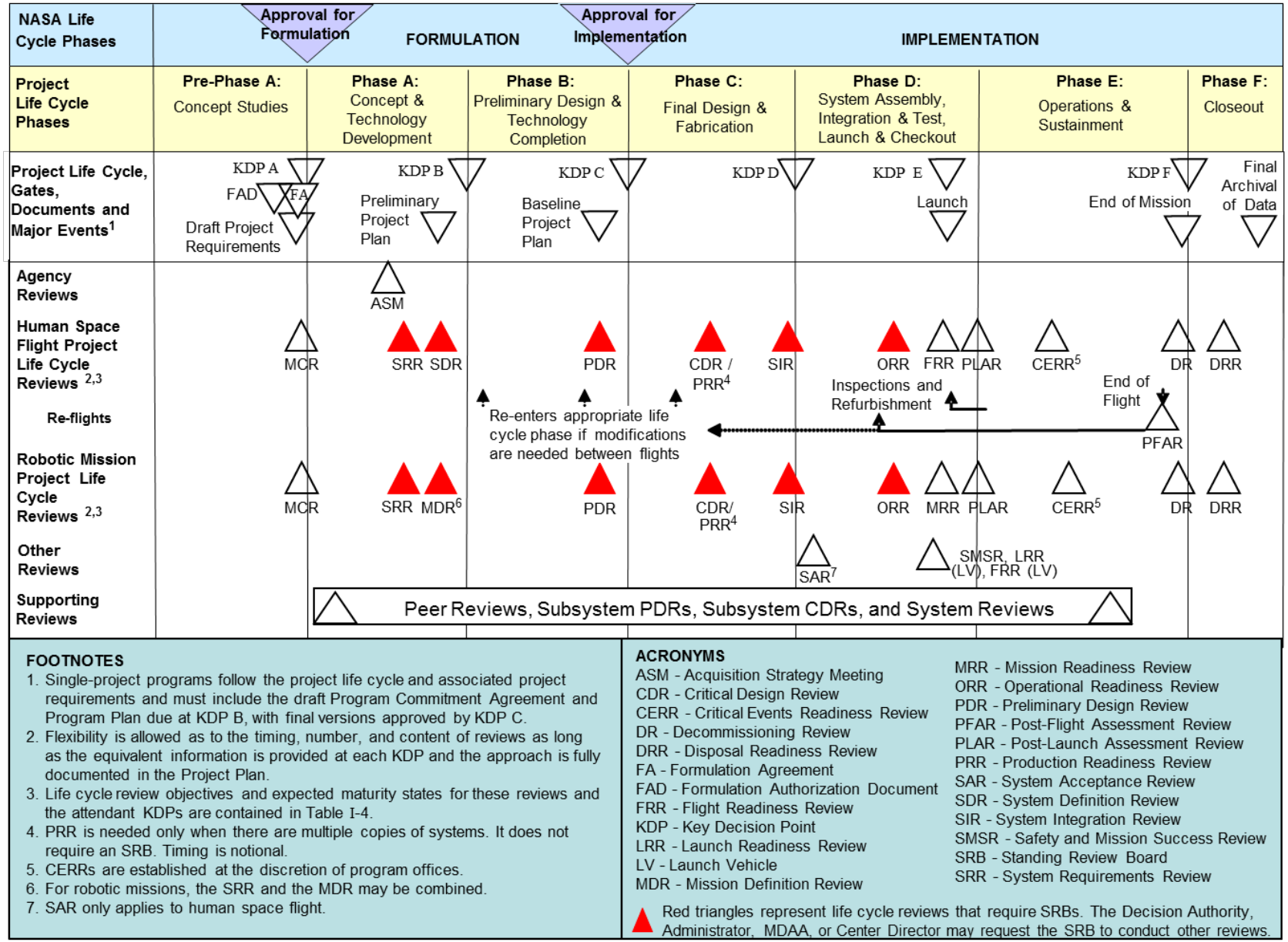
2.2.4.11 The Program Plan is used by the governing Program Management Council (PMC) in the review process to determine if the program is fulfilling its agreements. The draft Program Plan is reviewed at System Requirements Review (SRR) and is baselined following successful completion of SDR. The final Program Plan is reviewed at SDR and finally approved at KDP I. The content of the initial Program Plan baselined at KDP I reflects the maturity of the program at that point in time and acknowledges those areas, such as schedule and cost, that cannot be fully defined without further development. Program plans are updated and approved during the program life cycle, as necessary, to reflect updates to the PCA.

2.2.4.12 Programs may evolve over time as a result of a planned series of upgrades, the addition of new projects, when the need for new capabilities is identified, or a new mission is assigned to the program. When the requirements imposed on the program change, the Decision Authority will determine the necessity of going back through any or all of the previous life cycle phases.

2.2.4.13 **Project Life Cycle**

2.2.4.14 The NASA project life cycle is shown in Figure 2-4. This figure illustrates the project life cycle phases, gates, and major events, including KDPs and major reviews. Project KDPs and LCRs are analogous to program KDPs and LCRs. However, KDPs for projects are labeled with capital letters, e.g., KDP A. The letter corresponds to the project phase that will be entered after successfully passing through the gate. In practice, the activities described for each phase below are not always carried out exclusively in that phase; their timing will depend on the particular schedule requirements of the project. For example, some projects procure long-lead flight

hardware in Phase B to enable them to achieve their launch dates. Particularly during launch preparations, the flow of reviews is complex. An illustration of the detailed flow of these reviews is provided in Appendix D.



FOOTNOTES

1. Single-project programs follow the project life cycle and associated project requirements and must include the draft Program Commitment Agreement and Program Plan due at KDP B, with final versions approved by KDP C.
2. Flexibility is allowed as to the timing, number, and content of reviews as long as the equivalent information is provided at each KDP and the approach is fully documented in the Project Plan.
3. Life cycle review objectives and expected maturity states for these reviews and the attendant KDPs are contained in Table I-4.
4. PRR is needed only when there are multiple copies of systems. It does not require an SRB. Timing is notional.
5. CERRs are established at the discretion of program offices.
6. For robotic missions, the SRR and the MDR may be combined.
7. SAR only applies to human space flight.

ACRONYMS

ASM - Acquisition Strategy Meeting
CDR - Critical Design Review
CERR - Critical Events Readiness Review
DR - Decommissioning Review
DRR - Disposal Readiness Review
FA - Formulation Agreement
FAD - Formulation Authorization Document
FRR - Flight Readiness Review
KDP - Key Decision Point
LRR - Launch Readiness Review
LV - Launch Vehicle
MDR - Mission Definition Review
MRR - Mission Readiness Review
ORR - Operational Readiness Review
PDR - Preliminary Design Review
PFAR - Post-Flight Assessment Review
PLAR - Post-Launch Assessment Review
PRR - Production Readiness Review
SAR - System Acceptance Review
SDR - System Definition Review
SIR - System Integration Review
SMSR - Safety and Mission Success Review
SRB - Standing Review Board
SRR - System Requirements Review

▲ Red triangles represent life cycle reviews that require SRBs. The Decision Authority, Administrator, MDAA, or Center Director may request the SRB to conduct other reviews.

Figure 2-4 NASA Project Life Cycle

2.2.5 NASA places significant emphasis on project pre-Formulation and Formulation to ensure adequate preparation of project concepts and plans and mitigation of high-risk aspects of the project essential to position the project for the highest probability of mission success.

2.2.6 An MDAA has the authority to begin project pre-Formulation activities. Prior to initiating a new project, a Mission Directorate, typically supported by a program office, provides resources for concept studies (i.e., Pre-Phase A (Concept Studies)). While not formally a part of Formulation, some formulation-type activities will naturally occur as part of earlier advanced studies. These pre-Formulation activities involve design reference mission (DRM) analysis, feasibility studies, technology needs analyses, engineering systems assessments, and analyses of alternatives that should be performed before a specific project concept emerges. These trade studies are not considered part of formal project planning since there is no certainty that a specific project proposal will emerge. Pre-Formulation activities also involve identification of risks that are likely to drive the project's cost and schedule range estimates at KDP B and cost and schedule commitments at KDP C and include development of mitigation plans for those risks. At the conclusion of pre-Formulation, a FAD is issued authorizing Formulation to begin, and a Formulation Agreement[9] developed to document the plans and resources required for Formulation.

2.2.7 The Formulation Agreement is developed during Pre-Phase A. This agreement establishes the technical and acquisition work that needs to be conducted during Formulation to enable the project to commit to a successful plan for Implementation at KDP C and defines the schedule and funding requirements during Phase A and Phase B for that work. The Agreement focuses on the project activities necessary to accurately characterize the complexity and scope of the project. These activities include establishing the internal management control functions that will be used throughout the life of the project; increasing understanding of requirements; and identifying and mitigating high technical, cost, and schedule risks. The Agreement identifies and prioritizes the technical and acquisition activities that will have the most value and enable the project to develop high-confidence cost and schedule range estimates at KDP B and high-confidence cost and schedule commitments at KDP C. The Formulation Agreement serves as a tool for communicating and negotiating the project's formulation plans and prioritizing resource allocations with the program and Mission Directorate. The Agreement is approved and signed at KDP A (baselined for Phase A and preliminary for Phase B) and is updated (baselined for Phase B) and resubmitted for signature at KDP B.

2.2.8 Project Formulation consists of two sequential phases, denoted as Phase A (Concept and Technology Development) and Phase B (Preliminary Design and Technology Completion). During Formulation, the project establishes performance metrics, explores the full range of implementation options, defines an affordable project concept to meet requirements specified in the Program Plan, and develops needed technologies. Formulation is an iterative set of activities, rather than discrete linear steps. System engineering plays a major role during Formulation as described in NPR 7123.1, *NASA Systems Engineering Processes and Requirements.* The primary activities in these phases include developing and defining the project requirements; assessing the

[9] For AO-driven missions, the Phase B plan requested as part of the Concept Study Report serves to meet the requirements of the Formulation Agreement.

technology requirements, developing the plans to achieve them, and developing the technology; developing the system architecture; completing mission and preliminary system designs; flowing down requirements to the system/subsystem level; acquisition planning, including an analysis of the industrial base capability to design, develop, produce, support, and—if appropriate— restart an acquisition program or project; evaluating and refining subsystem interfaces; assessing heritage (the applicability of designs, hardware, and software in past projects to the present one); conducting performance, cost, and risk trades; identifying and mitigating development and programmatic risks, including supply chain risks; conducting engineering development activities, including developing engineering prototypes and models for the higher risk components and assemblies that have not been previously built or flown in the planned environment and testing them to demonstrate adequate performance; developing time-phased cost and schedule estimates and documenting the basis of these estimates; and preparing the Project Plan for Implementation. Formulation continues with execution of its activities, normally concurrently, until Formulation output products, such as the Project Plan have matured and are acceptable to the program manager, Center Director, and MDAA. These activities allow the Agency to present to external stakeholders high-confidence time-phased cost plans and schedule range estimates at KDP B and high-confidence cost and schedule commitments at KDP C.

2.2.9 For competed missions, some Mission Directorates have chosen to use one or two steps to initiate “competed” or “AO-driven” projects within a space flight program. In a one-step AO process, projects are competed and selected for Formulation in a single step. In two-step competitions, several projects may be selected in Step 1 and given time to mature their concepts in a funded concept study before the Step 2 down-selection. Program resources are invested (following Step 1 selections) to bring these projects to a state in which their science content, cost, schedule, technical performance, project implementation strategies, safety and mission assurance strategies, heritage, technology requirements and plans, partnerships, and management approach can be better judged. From the point of view of the selected AO-driven project, the proposing teams are clearly doing formal project Formulation (e.g., typical Phase A tasks, such as putting together a detailed WBS, schedules, cost estimates, and Implementation plan) during the concept study and the preparation of the Step 2 concept study report. From the point of view of the program, no specific project has been chosen, the total cost is not yet known, and project requirements are not yet finalized, yet Formulation has begun. Therefore, for missions selected as a result of an AO, KDP A is the selection of a Step 1 proposal for concept development. In a one-step AO process, projects enter Phase A after selection (KDP A) and the process becomes conventional. In a two-step AO process, projects are down-selected following evaluation of concept study reports and the down-selection serves as KDP B. Following this selection, the process becomes conventional—with the exception that KDP B products requiring Mission Directorate input will be finished as early in Phase B as feasible.

2.2.10 Project Implementation consists of phases C, D, E, and F. Decision Authority approval at KDP C marks the transition from Phase B of Formulation to Phase C of Implementation. During Phase C (Final Design and Fabrication) and Phase D (System Assembly, Integration and Test, and Launch), the primary activities are developmental in nature, including acquisition contract execution. Phase C includes completion of final system design and the fabrication, assembly, and test of components, assemblies, and subsystems. Phase D includes system assembly, integration, and test; preparation for the Flight Readiness Review (FRR) (human space flight projects) or Mission Readiness Briefing (MRB) (robotic space flight projects); pre-launch activities; launch;

and initial on-orbit checkout. All activities are executed per the Project Plan developed during Formulation. KDP E marks approval to launch. The process for completing KDP E is complex and the events and reviews leading up to KDP E are shown in Appendix D. To facilitate a smooth flow leading to launch approval, the PMC meetings are the FRR for Human Space Flight and the MRB for Robotic Space Flight. After successful on-orbit checkout, the project transitions to Phase E. The start of Phase E (Operations and Sustainment) marks the transition from system development and acquisition activities to primarily systems operations and sustainment activities. In Phase F (Closeout), project space flight and associated ground systems are taken out of service and safely disposed of, although scientific and other analyses might still continue under project funding. Independent evaluation activities occur throughout all phases.

2.2.11 **Key Project Documents**

2.2.11.1 To initiate a project's official entry into Formulation, the program manager prepares a draft project FAD or equivalent (such as a Program Plan section, MDAA letter selecting a specific AO proposal, or a Program Directive). Following Agency strategic acquisition planning, the draft FAD will be updated and forwarded to the MDAA for signature. The project FAD authorizes a project manager to initiate the planning of a new project and to perform the analysis of alternatives required to formulate a sound Formulation Agreement and subsequent Project Plan and contains requirements, schedules, and project funding requirements. A project enters Formulation when the MDAA signs the FAD in preparation for KDP A.

2.2.11.2 The Formulation Agreement is prepared by the project in response to the FAD to establish the technical and acquisition work that needs to be conducted during Formulation and defines the schedule and funding requirements during Phase A and Phase B for that work.

Project Plan

2.2.11.3 The Project Plan is an agreement among the MDAA; the program manager; participating Center Director(s); the project manager; and for AO-driven missions, the Principal Investigator[10]. The Project Plan is prepared by the project manager with the support of the project team and defines at a high level the project's objectives, technical and management approach, environment within which the project operates, and commitments of the project to the program. The Project Plan is required by the governing PMC and is used in the review process to determine if the project is fulfilling its agreements. The Project Plan must be consistent with the Program Plan. The Project Plan is updated, at a minimum, when there is a significant change.

2.2.11.4 The Project Plan is the key document that reflects Formulation results. The Project Plan is a product of the Formulation Phase and describes how the project will execute the Implementation Phase. Larger and more complex projects may find it necessary or desirable to write separate control plans to convey project approaches and strategies. In these cases, the Project Plan summarizes the key elements of such separate plans. In smaller projects, separate

[10] A Principal Investigator is a person who conceives an investigation and is responsible for carrying it out and reporting its results. In some cases, Principal Investigators from industry and academia act as project managers for smaller development efforts with NASA personnel providing oversight.

and detailed control plans may not be needed to document project approaches, and the Project Plan itself serves as the single source for such information.

2.2.11.5 The project manager supports, as requested, the Mission Directorate and program manager in developing program-level documentation for the project, and the project manager flows information down into project-level documentation. If requested by the program manager, the project manager assists in preparing a revised PCA and/or Program Plan. The project manager also supports, as requested, generating the program requirements on the project and their formal documentation in the Program Plan (or as an appendix to the Program Plan). After the program requirements on the project are established, the project manager and the project team develop technical approaches and management plans to implement the requirements. These products are formally documented in the Project Plan. The project manager is then responsible for the evolution of the project concept and ultimate project success. The project manager supports the program manager and the Mission Directorate in keeping the project's baseline life cycle cost estimates and funding strategy and the annual NASA budget submissions consistent.

2.3 Program and Project Oversight and Approval

2.3.1 This section describes NASA's oversight approach for programs and projects, defines KDPs, and identifies the Decision Authority.

2.3.2 The Decision Authority is the Agency's responsible individual who determines whether and how the program or project proceeds through the life cycle and the key program or project cost, schedule, and content parameters that govern the remaining life cycle activities. For programs and Category 1 projects, the Decision Authority is the NASA AA. The NASA AA may delegate this authority to the MDAA for Category 1 projects. For Category 2 and 3 projects, the Decision Authority is the MDAA. The MDAA may delegate to a Center Director Decision Authority to determine whether Category 2 and 3 projects may proceed through KDPs into the next phase of the life cycle. The authority for these projects may be delegated to a Center Director. All delegations are documented and approved in the applicable authority document (PCA or Program Plan) depending on which Decision Authority is delegating.

2.3.3 To ensure the appropriate level of management oversight, NASA has established two levels of PMCs—the Agency PMC (APMC) and Mission Directorate PMCs (MD PMCs). The PMCs have the responsibility for periodically evaluating the technical, safety, and programmatic performance (including cost, schedule, risk, and risk mitigation) and content of a program or project under their purview. These evaluations focus on whether the program or project is meeting its commitments to the Agency. Each program and project has a governing PMC. For all programs and Category 1 projects, the governing PMC is the APMC; for Category 2 and 3 projects, the governing PMC is the MD PMC. Table 2-2 shows the governing management councils for programs and projects (by category).

Table 2-2 Relationship Between Programs/Projects and PMCs

	Agency PMC	Mission Directorate PMC
Programs	○	■
Category 1 Projects	○	■

Category 2 Projects		○
Category 3 Projects		○

○ - Indicates governing PMC ■ - Indicates PMC evaluation

2.3.3.1 The Agency PMC is the governing PMC for all programs and Category 1 projects. In that capacity, it evaluates them immediately prior to KDPs and then recommends approval or disapproval to the Decision Authority regarding entrance to the next life cycle phase. The Agency PMC also performs program oversight during Formulation and Implementation.

2.3.3.2 A Mission Directorate PMC (MD PMC) evaluates all programs and projects executed within that Mission Directorate and provides input to the MDAA. For programs and Category 1 projects, the MDAA carries forward the MD PMC findings and recommendations to the Agency PMC. For Category 2 and 3 projects, the MD PMC serves as the governing PMC and recommends approval or disapproval to the Decision Authority regarding entry to the next phase. For Category 3 projects, the Decision Authority may designate an alternate body to govern. Such designations and delegations are documented in the Project Plan and the relevant Program Plan.

2.3.4 The Center Director (or designee) oversees programs and projects, usually through theCenter Management Council (CMC), which monitors and evaluates all program and project work (regardless of category) executed at that Center. The CMC evaluation focuses on whether Center engineering, Safety and Mission Assurance (SMA), health and medical, and management best practices (e.g., program and project management, resource management, procurement, institutional best practices) are being followed by the program or project under review, and whether Center resources support program/project requirements. The CMC also assesses program and project risk and evaluates the status and progress of activities to identify and report trends and provide guidance to the Agency and affected programs and projects. The CMC provides its findings and recommendations to program or project managers and to the appropriate PMCs regarding the performance and technical and management viability of the program or project prior to KDPs. The Center Director makes recommendations to the Decision Authority at KDPs regarding the ability of the program or project to execute successfully. These recommendations consider all aspects including programmatic, technical, and major risks and strategy for their mitigation and are supported by independent analyses, when appropriate.

2.3.4.1 For tightly coupled programs, an Integrated CMC (ICMC) is used. The ICMC includes the Center Director (or representative) from each Center responsible for management of a project within the program and each Center with a substantial program development role. The ICMC is chaired by the Center Director (or representative) responsible for program management.

2.3.4.2 An ICMC also generally is used for programs and projects that are conducted by multiple Centers and includes the Center Director (or representative) from each Center with substantial contributions. The ICMC is chaired by the Center Director (or representative) responsible for the program/project management.

2.3.5 Following each LCR, the SRB and the program or project brief the applicable management councils (including the CMC or ICMC, MD PMC, and governing PMC) on the results of the LCR to support the councils' assessments. These briefings must be completed to support the final briefing to the Decision Authority within 30 days. These briefings cover the objectives of the review; the maturity expected at that time; findings and recommendations to rectify issues or improve mission success; the program or project's response to these findings;

and the program or project's proposed cost, schedule, and technical plans for their follow-on phases. This enables a disciplined Agency assessment approach leading up to the Decision Authority's decision.

2.3.6 The potential outcomes at a KDP (with the exception of KDP E, which is approval for launch) include:

a. Approval to enter the next program or project phase, with or without actions.

b. Approval to enter the next phase, pending resolution of actions.

c. Disapproval for continuation to the next phase. In such cases, follow-up actions may include:

(1) A request for more information and/or a follow-up review that addresses significant deficiencies identified as part of the LCR;

(2) A request for a Termination Review for the program or the project (phases B, C, D, and E only);

(3) Direction to continue in the current phase; or

(4) Redirection of the program or project.

2.3.7 To support a KDP decision process, appropriate supporting material is submitted to the Decision Authority. These materials include:

a. The governing PMC review recommendation.

b. The SRB report.

c. The MDAA recommendation (for programs and Category 1 projects).

d. The program manager recommendation.

e. The project manager recommendation (for project KDPs).

f. The program or project's proposed cost, schedule, and technical plans for their follow-on phases. This includes the proposed preliminary and final project baselines at KDPs B and C, respectively.

g. The CMC/ICMC recommendation.

h. Summary status of action items from previous KDP (with the exception of KDP A).

i. Program/project documents or updates signed or ready for signature (for example, the program FAD, Program Plan, PCA, Project Formulation Agreement, Project Plan, Memoranda of Understanding (MOUs), and Memoranda of Agreement (MOAs)).

j. Draft Decision Memorandum and supporting data. (See below.)

k. Summary of accepted risks and waivers.

2.3.8 After reviewing the supporting material and completing discussions with all parties, the Decision Authority determines whether and how the program or project proceeds and approves any additional actions. These decisions are summarized and recorded in the Decision Memorandum. The Decision Authority completes the KDP by signing the Decision Memorandum. The expectation is to have the Decision Memorandum signed at the conclusion of the governing PMC KDP meeting. The Decision Authority archives the KDP documents with the Agency Chief Financial Officer and the program and project manager attaches the approved KDP Decision Memorandum to their Program or Project Plan. Any appeals of the Decision Authority's decisions go to the next higher Decision Authority.

2.3.9 **Baseline Performance Review**

2.3.9.1 In addition, NASA's senior leadership gains monthly insight into the status and performance of the Agency's programs and projects at the Baseline Performance Review (BPR). Coordinated by the OCE, the BPR provides comprehensive, integrated, and objective information assessing the performance to plan of programs, projects, and institutional capabilities. This visibility into the execution of the Agency's programmatic activities through open, cross-functioning communication allows identification and analysis of performance trends and crosscutting or systemic issues and risks. As a result, issues that need attention can be identified and actions taken to improve program or project performance, enhancing overall Agency performance.

2.4 Approving and Maintaining Program and Project Plans, Baselines, and Commitments

2.4.1 The Decision Memorandum describes the Decision Authority's decisions. When the Decision Authority approves the program or project's entry into the next phase of the life cycle, the Decision Memorandum describes the constraints and parameters within which the Agency, the program manager, and the project manager will operate; the extent to which changes in plans may be made without additional approval; and any additional actions that came out of the KDP. (See the Decision Memorandum template with signature page in Appendix e, which illustrates the level and types of information that are documented.)

2.4.1.1 The Management Agreement contained within the Decision Memorandum defines the parameters and authorities over which the program or project manager has management control. A program or project manager has the authority to manage within the Management Agreement and is accountable for compliance with the terms of the agreement. The Management Agreement, which is documented at every KDP, may be changed between KDPs as the program or project matures and in response to internal and external events. The Management Agreement should be viewed as a contract between the Agency and the program or project manager. A divergence from the Management Agreement that any party identifies as significant shall be accompanied by an amendment to the Decision Memorandum.

2.4.1.2 During Formulation, the Decision Memorandum documents the key parameters related to work to be accomplished during each phase of Formulation. It also establishes a target life cycle cost (LCC) range (and schedule range, if applicable) that the Decision Authority determines is reasonable to accomplish the program or project. Given the program or project's lack of maturity during Formulation, this range reflects the broad uncertainties regarding the program or project's scope, technical approach, acquisition strategy, implementation schedule, and associated costs. The range is the basis for coordination with the Agency's stakeholders. At KDP B, a more refined LCC range is developed. (See Figure 2-5, Example of Agreements and Commitments in Terms of Cost for Projects.)

2.4.1.3 Within the Decision Memorandum, the parameters and authorities over which the program or project manager has management control constitute the program or project Management Agreement. A program or project manager has the authority to manage within the Management Agreement and is accountable for compliance with the terms of the agreement. The Management Agreement is documented at every KDP but may be changed between KDPs as the program or project matures and in response to internal and external events. The Management Agreement should be viewed as a contract between the Agency and the program or project manager. A significant divergence from the Management Agreement is accompanied by an amendment to the Decision Memorandum to provide mutually agreed to changes in content, estimated cost, and/or a revised Joint Cost and Schedule Confidence Level (JCL), when required.

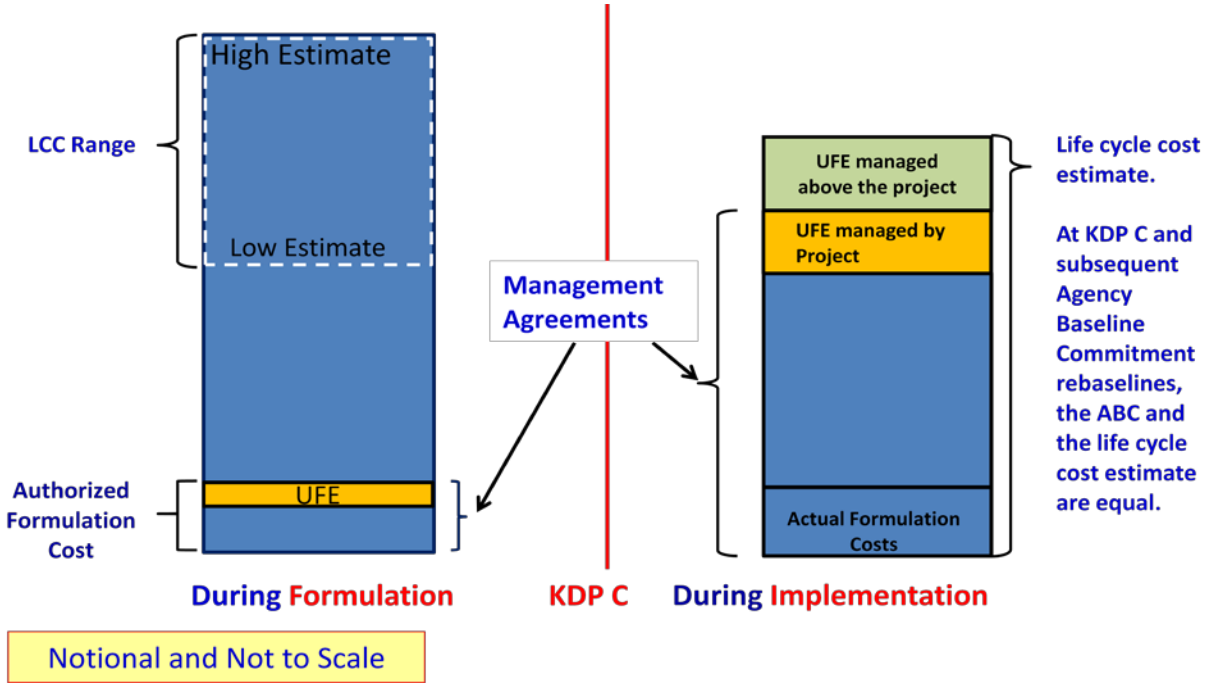


Figure 2-5 Example of Agreements and Commitments in Terms of Cost for Projects

2.4.1.4 Also documented in the Decision Memorandum are any additional resources beyond those explicitly estimated or requested by the program/project (e.g., additional schedule margin). When the Decision Authority determines additional resources are needed, the Decision Authority

approves the resources, establishes the upper Agency limit for the resources, and defines the authority for using the resources. One potential additional resource explicitly identified in the Management Agreement is Unallocated Future Expenses (UFE) assigned to the program or project manager, which are costs that are expected to be incurred but cannot yet be allocated to a specific WBS subelement of a program's or project's plan. Management control of some UFE may be retained above the level of the project (i.e., Agency or program). (See Figure 2-5.)

2.4.1.5 During Implementation, Decision Memorandums document the parameters for the entire life cycle of the program or project. Programs and projects transition from Formulation to Implementation at KDP I for programs and KDP C for projects when the Agency determines the mission scope, concept, resource requirements, schedule, etc., are sufficiently mature. At this point, the life cycle cost estimate of the program or project is no longer documented as a range, but instead as an estimated number. The life cycle cost estimate includes all costs, including UFE, for development (excluding Pre-Phase A) through prime mission operation to disposal, excluding extended operations. (See full definition in Appendix A.)

2.4.1.6 All projects document the Agency's life cycle cost estimate and other parameters in the Decision Memorandum for Implementation (KDP C), and this becomes the Agency Baseline Commitment (ABC). The ABC is the baseline against which the Agency's performance is measured during the Implementation Phase. Tightly coupled programs also document their life cycle cost estimate and other parameters in their Decision Memorandum and ABC at KDP I.

2.4.1.7 The ABC for projects with a life cycle cost greater than $250 million forms the basis for the Agency's external commitment to the Office of Management and Budget (OMB) and Congress. The NASA Administrator's agreement is required for the ABCs for all programs and projects with a life cycle cost greater than $1 billion and all Category 1 projects. The NASA Associate Administrator (AA) approves all ABCs for programs requiring an ABC and projects with a life cycle cost greater than $250 million. There are Agency controls on when and how changes to the ABC can be made and, when this occurs, the ABC change is known as a "rebaseline." The process and controls for rebaselining are described in paragraph 2.4.3. The Agency expects the commitments made at KDP C or KDP I will be met. Therefore, the approved life cycle cost estimate in the Decision Memorandum and the ABC should remain the same throughout Implementation. However, if the program or project requires additional resources over and above the ABC, the life cycle cost estimate may exceed the ABC and will be tracked as an overrun. Figure 2-5 depicts the relationships between the life cycle cost estimate, Management Agreement, ABC, and UFE for a project.

2.4.2 The Decision Memorandum is approved by the Decision Authority. Other required signatures for concurrence are the Chief, SMA; Chief Health and Medical Officer (if needed); Chief Financial Officer; Independent Program Assessment Office (IPAO) AA; NASA Chief Engineer; Center Directors of Centers with a substantial development role; MDAA; program manager; project manager; the Principal Investigator (when applicable); and the NASA Associate Administrator for projects with a life cycle cost estimate greater than $250 million. Signatories of a Decision Memorandum acknowledge acceptance of their respective roles in and support of the program or project in accordance with the memorandum and the associated Program or Project Plan.

2.4.2.1 The Decision Memorandum is amended by the signing parties (including the Decision Authority) between KDPs to reflect changes to the Management Agreement, life cycle cost estimate, or ABC. Such changes include changes in the estimated cost or schedule associated with the approved scope, changes in the budget or funding profile that may drive a change in schedule, or a change to the program or project scope[11]. Amendments to the Decision Memorandum will also identify any significant changes in program or project risk. The NASA Associate Administrator is notified of amendments that reflect a growth in the program or project life cycle cost, development cost, or schedule estimate beyond the ABC.

2.4.2.2 Between KDPs, the Management Agreement may be changed without amending the Decision Memorandum if there is a change in UFE allocation to the program or project that does not affect the approved life cycle cost estimate. In this case, changes to the Management Agreement will be documented and signed by the Mission Directorate and the program manager or the program manager and project manager. A record of the changed Management Agreement will be attached to the Project Plan (and Program Plan as applicable) and reported to the Chief Financial Officer (CFO) in a timely manner.

2.4.3 The Agency has established requirements for rebaselining the ABC. This rebaselining is required when: (1) the estimated development cost[12] exceeds the ABC development cost by 30 percent or more and Congress has reauthorized the project; (2) the NASA Associate Administrator (AA) judges that events external to the Agency make a rebaseline appropriate; or (3) the NASA AA judges that the program or project scope defined in the ABC has been changed or the tightly coupled program or project has been interrupted. ABCs for projects are not rebaselined to reflect cost or schedule growth that does not meet one or more of these criteria.

2.4.3.1 When an ABC is rebaselined, the Decision Authority directs that a review of the new baseline be conducted by the SRB or as determined by the Decision Authority. The Decision Authority will determine the scope and depth of the review for the extant phase that must be re-examined. As part of this, an independent cost and schedule assessment will be performed. The results of the Rebaseline Review will be documented and presented to the Decision Authority, and a new Decision Memorandum will document the decision.

2.4.4 Cost and Schedule Estimates

2.4.5 Cost and schedule estimates have an essential role in program and project management and must have a sound documented basis. All programs and projects develop cost estimates and planned schedules for the work to be performed in the current and following life cycle phases. As part of developing these estimates, the program or project shall document the basis of estimate (BOE) in retrievable program or project records. The BOE documents the ground rules, assumptions, and drivers used in cost and schedule estimate development and includes applicable model inputs, rationale/justification for analogies, and details supporting bottom-up cost and schedule estimates. Program and project planning must be consistent with:

[11] "Project scope" encompasses the approved programmatic content and deliverables.

[12] 'Development cost" includes all project costs from authorization to proceed to Implementation (Phase C) through operational readiness at the end of Phase D.

a. Coverage of all costs associated with obtaining a specific product or service, including:

   (1) Costs, such as institutional funding requirements, technology investments, and multi-Center operations;

   (2) Costs associated with Agency constraints (e.g., workforce allocations at Centers); and

   (3) Costs associated with efficient use of Agency capital investments, facilities, and workforce.

b. Resources projected to be available in future years based on the Agency's strategic resource planning. This includes the annual mission and support portfolio reviews and resulting direction and the NASA budget process (i.e., Planning, Programming, Budgeting, and Execution (PPBE)).

c. A cost- and risk-informed schedule at KDP A and a risk-informed, cost-loaded schedule at all other KDPs.

d. Decisions and direction documented in the program or project's approved Decision Memorandum.

e. Evaluation of suppliers' qualifications and past performance and the realism embodied in the suppliers' cost and schedule proposals.

f. Reconciled estimates (differences are understood and their rationale documented) when independent estimates are required by the Decision Authority.

2.4.6 **Estimates and Probabilistic Analysis**

2.4.6.1 Probabilistic analysis of cost and/or schedule estimates is required for tightly coupled programs, single-project programs (regardless of life cycle cost), and projects with an estimated life cycle cost greater than $250 million. When the probabilistic analysis is required for only one parameter (i.e., cost or schedule) or when generally referring to a probabilistic assessment of the level of confidence of achieving a specific goal, the analysis is referred to merely as a "confidence level." This analysis is referred to as a Joint Cost and Schedule Confidence Level (JCL) when the analysis is required to measure the likelihood of meeting both cost and schedule. A JCL is defined as the probability that actual cost and schedule will be equal to or less than the targeted cost and schedule. For example, a 70 percent joint schedule confidence level is the point on the joint cost and schedule probability distribution curve where there is a 70 percent probability that the project or program will be completed at or lower than the estimated cost and on or before the estimated schedule. (See *NASA Cost Estimating Handbook* (CEH).)

2.4.7 **Cost and Schedule Estimate Requirements by Program and Project Type**

2.4.7.1 Because characteristics and approval and reporting requirements of individual program and project types vary, the requirements related to cost and schedule estimates also vary, as described below.

2.4.7.2 Tightly Coupled and Single Project Programs and Larger Projects

a. For tightly coupled programs and single-project programs (regardless of life cycle cost), and projects with an estimated life cycle cost greater than $250 million, a range of cost and a range for schedule are provided at KDP 0/KDP B. Each range (with confidence levels identified for the low and high values of the range) is established by a probabilistic analysis and is based on identified resources and associated uncertainties by fiscal year. Separate analyses of cost and schedule, each with associated confidence levels, meet the requirement. A joint cost and schedule confidence level (JCL) is not required but may be used at KDP 0 and KDP B.

b. Until KDP I/KDP C, the larger value from the cost range estimate and the longer time from the schedule range estimate are expected to be used in phased budget submissions.

c. At KDP I/KDP C, tightly coupled and single-project programs (regardless of life cycle cost) and projects (with an estimated life cycle cost greater than $250 million) develop a cost-loaded schedule and perform a risk-informed probabilistic analysis that produces a JCL. The JCL is the product of a probabilistic analysis of the coupled cost and schedule to measure the likelihood of completing all remaining work at or below the budgeted levels and on or before the planned completion of Phase D. The program or project needs to demonstrate that the cost, schedule, and risk associated with work not completed in Formulation have been incorporated. The JCL calculation includes any operations occurring prior to the transition to Phase E unless otherwise approved by the Decision Authority.

d. Mission Directorates shall plan and budget tightly coupled and single-project programs (regardless of life cycle cost) and projects (with an estimated life cycle cost greater than $250 million) based on a 70 percent joint cost and schedule confidence level or as approved by the Decision Authority.

e. Any JCL approved by the Decision Authority at less than 70 percent is justified and documented.

f. Mission Directorates ensure that funding for these projects is consistent with the Management Agreement and, in no case, is less than the equivalent of a 50 percent JCL.

g. Programs and projects that are in operational phases generally are not required to develop or maintain confidence level estimates. The adequacies of time-phased cost plan requests for operational phases are demonstrated and evaluated through the annual budget cycle processes. However, the Agency policy to provide joint cost and schedule confidence level estimating applies to significant developments related to new or upgraded capabilities included in operations.

2.4.7.3 Loosely Coupled and Uncoupled Programs

a. Loosely coupled and uncoupled programs are not required to develop program cost and schedule confidence levels. These programs provide analysis that provides a status of the

program's risk posture that is presented as each new project reaches KDP B and C or when a project's ABC is rebaselined.

b. Projects in these programs with an expected life cycle cost greater than$250 million are covered in the paragraphs above.

2.4.7.4 After KDP C, as part of the PPBE process, the responsible MDAA reviews programs and projects and informs the NASA Associate Administrator whether or not the current baseline life cycle cost estimate, funding strategy, and annual NASA budget submissions remain consistent. In addition, an assessment is provided of the program or project's projected performance relative to the ABC.

2.4.7.5 Monthly review processes, including the Baseline Performance Review (BPR), are used to help the Decision Authority make a determination whether a program or project needs to have a JCL recalculated or to be rebaselined.

2.5 Program and Project Life Cycle Reviews

2.5.1 The program and project life cycle reviews identified in the program and project life cycles (figures 2-3a, 2-3b, and 2-4) are essential elements of conducting, managing, evaluating, and approving space flight programs and projects. These life cycle reviews assess the following criteria:

a. Alignment with and contribution to Agency strategic goals and the adequacy of requirements that flow down from those. The scope of this criterion includes alignment of program or project requirements/designs with Agency strategic goals, program requirements, and constraints, mission needs and success criteria; allocation of program requirements to projects; and proactive management of changes in program or project scope and shortfalls.

b. Adequacy of management approach. The scope of this criterion includes program or project authorization, management framework and plans, acquisition strategies, and internal and external agreements.

c. Adequacy of technical approach, as defined by NPR 7123.1 entrance and success criteria. The scope of this criterion includes flow down of project requirements to systems/subsystems; architecture and design; and operations concepts that respond to and satisfy imposed requirements and mission needs.

d. Adequacy of the integrated cost and schedule estimate and funding strategy in accordance with NPD 1000.5. The scope of this criterion includes cost and schedule control plans; cost and schedule baselines that are consistent with the program or project requirements, assumptions, risks, and margins; basis of estimate; JCL (when required); and alignment with planned budgets.

e. Adequacy and availability of resources other than budget. The scope of this criterion includes planning, availability, competency and stability of staffing, infrastructure, and the industrial base/supplier chain requirements.

f. Adequacy of the risk management approach and risk identification and mitigation per NPR 8000.4, *Agency Risk Management Procedural Requirements*. The scope of this criterion includes risk-management control plans, open and accepted risks, risk assessments, risk mitigation plans, and resources for managing/mitigating risks.

2.5.2 LCRs are conducted under documented Agency and Center review processes. The life cycle review process provides:

a. The program or project with a credible, objective assessment of how they are doing.

b. NASA senior management with an understanding of whether:

(1) The program/project is on track to meet program or project objectives,

(2) The program or project is performing according to plan, and

(3) Impediments to program or project success are addressed.

c. A credible basis for the Decision Authority to approve or disapprove the transition of the program or project at a KDP to the next life cycle phase.

2.5.3 For each LCR and each KDP, expected maturity states are defined to establish and ensure phase-appropriate maturation of a program or project and provide a high-level basis for determining whether the objectives and requirements of the LCR or KDP have been met. Expected maturity states are categorized by the life cycle review criteria identified in Section 2.6.1. The expected maturity state for LCRs and KDPs are defined in Appendix F, tables F-1, F-2, and F-3 for uncoupled and loosely coupled programs, tightly coupled programs, and projects, respectively. These tables also provide objectives for program and project LCRs and the overall expected maturity states for program and project KDPs. (Table F-4 provides the objectives for other program and project reviews depicted in figures 2-3a, 2-3b, and 2-4).

2.5.4 LCR entrance and success criteria in Appendix G of NPR 7123.1 and the life cycle phase and KDP requirements in NPR 7120.5 provide specifics for addressing the expected maturity state including the expected maturity of milestone products and control plans. The expected maturity state for an LCR that immediately precedes a KDP addresses the maturity requirements of that KDP. The expected maturity state for an LCR that does not immediately precede a KDP defines the expected progress toward meeting the maturity requirements of the next KDP.

2.5.5 Prior to life cycle reviews, programs and projects conduct internal reviews to initially establish and then manage the program or project to the baselines. These internal reviews are the decisional meetings wherein the program/projects solidify their plans, technical approaches, and programmatic commitments. This is accomplished as part of the normal systems engineering work processes as defined in NPR 7123.1 wherein major technical and programmatic requirements are assessed along with the system design and other implementation plans. For both robotic and human space flight projects, these internal reviews are typically lower level system and subsystem reviews that lead to and precede the life cycle review. Major technical and programmatic performance metrics are reported and assessed against predictions.

2.5.6 Following completion of the internal reviews, the LCRs depicted in figures 2-3a, 2-3b, and 2-4 are conducted. The life cycle review may be a one-step review or a two-step review. Figure 2-6, One-Step PDR Life Cycle Review Overview, and Figure 2-7, Two-Step PDR Life Cycle Review Overview, illustrate a one-step and a two-step PDR life cycle review, respectively. However, one-step and two-step reviews are generally applicable, and either may be used for any life cycle review. The program or project will determine, in coordination with the responsible Center and Mission Directorate, if reviews will be conducted using the one- or two-step review process. When a two-step review is selected, it is specified whether the first step is chaired by the program or project, the SRB chair, or a representative of a Center organization. This review approach is specified in the project review plan and documented in the Terms of Reference (ToR). As depicted in figures 2-6 and 2-7, a life cycle review is preceded by a Readiness Assessment (see Section 2.5.6.2) and includes one or two Snapshot Reports (see Section 2.5.6.6). It may also include one or more Checkpoints. A life cycle review is complete when the governing PMC and Decision Authority complete their assessment.

2.5.6.1 Life cycle reviews (with the exceptions of those noted in Table 2-3) are a joint effort between the program or project and an independent Standing Review Board (SRB). Paragraphs 2.5.7 through 2.5.11 provide information on the formation of these SRBs. In addition, NASA has issued the *NASA Standing Review Board Handbook*. The purpose of the *SRB Handbook* is to provide the philosophy and guidelines for the setup, processes, and products of SRBs in support of the Agency's implementation of its independent life cycle review process. The *SRB Handbook* is written to provide guidance to the NASA program and project communities and the SRBs regarding the expectations, processes, products, timelines, and working interfaces with NASA Mission Directorates (MDs), Centers, review organizations, and Management Councils.

One-Step[1] PDR
Life Cycle Review Overview (Example)

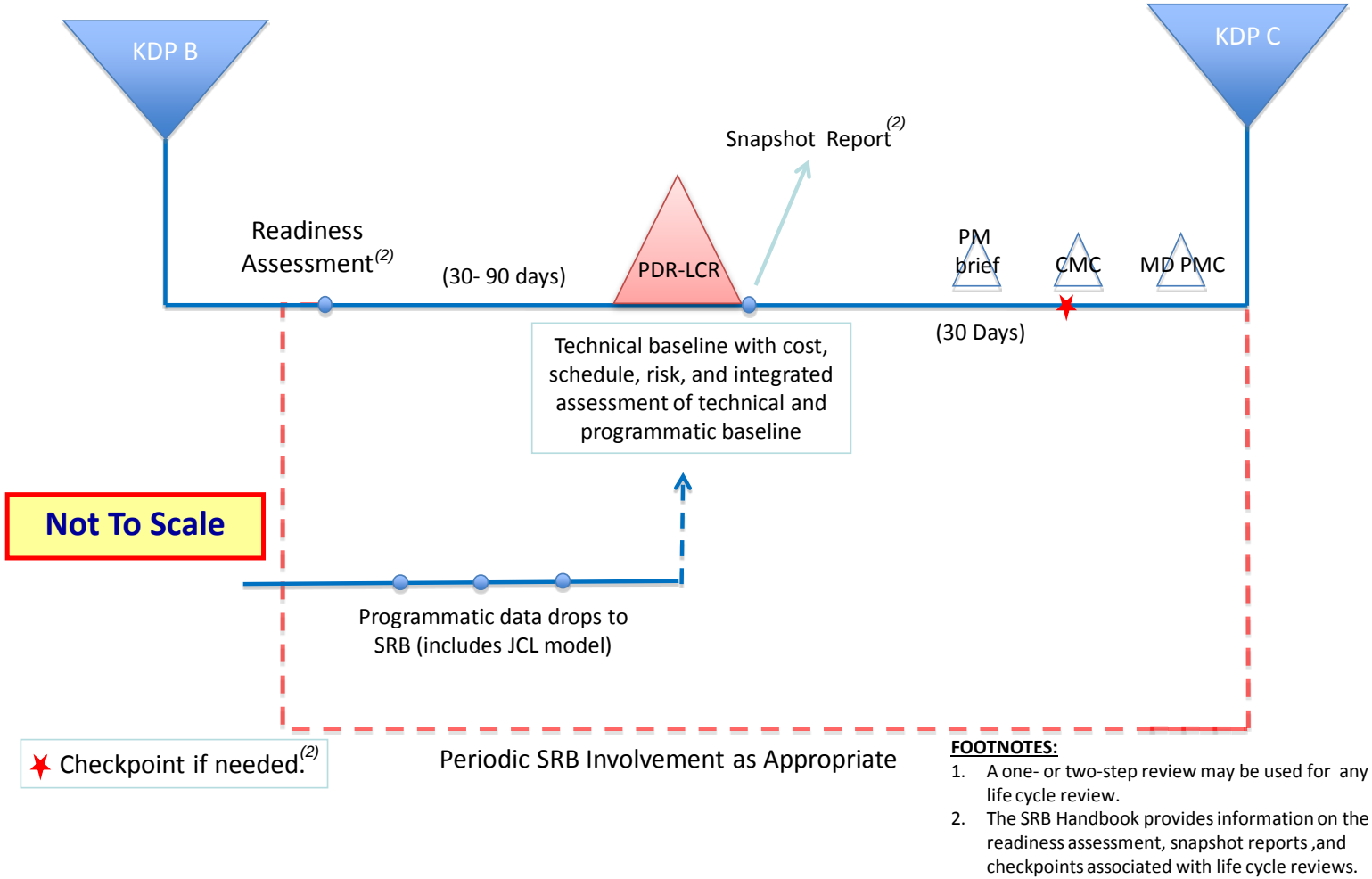
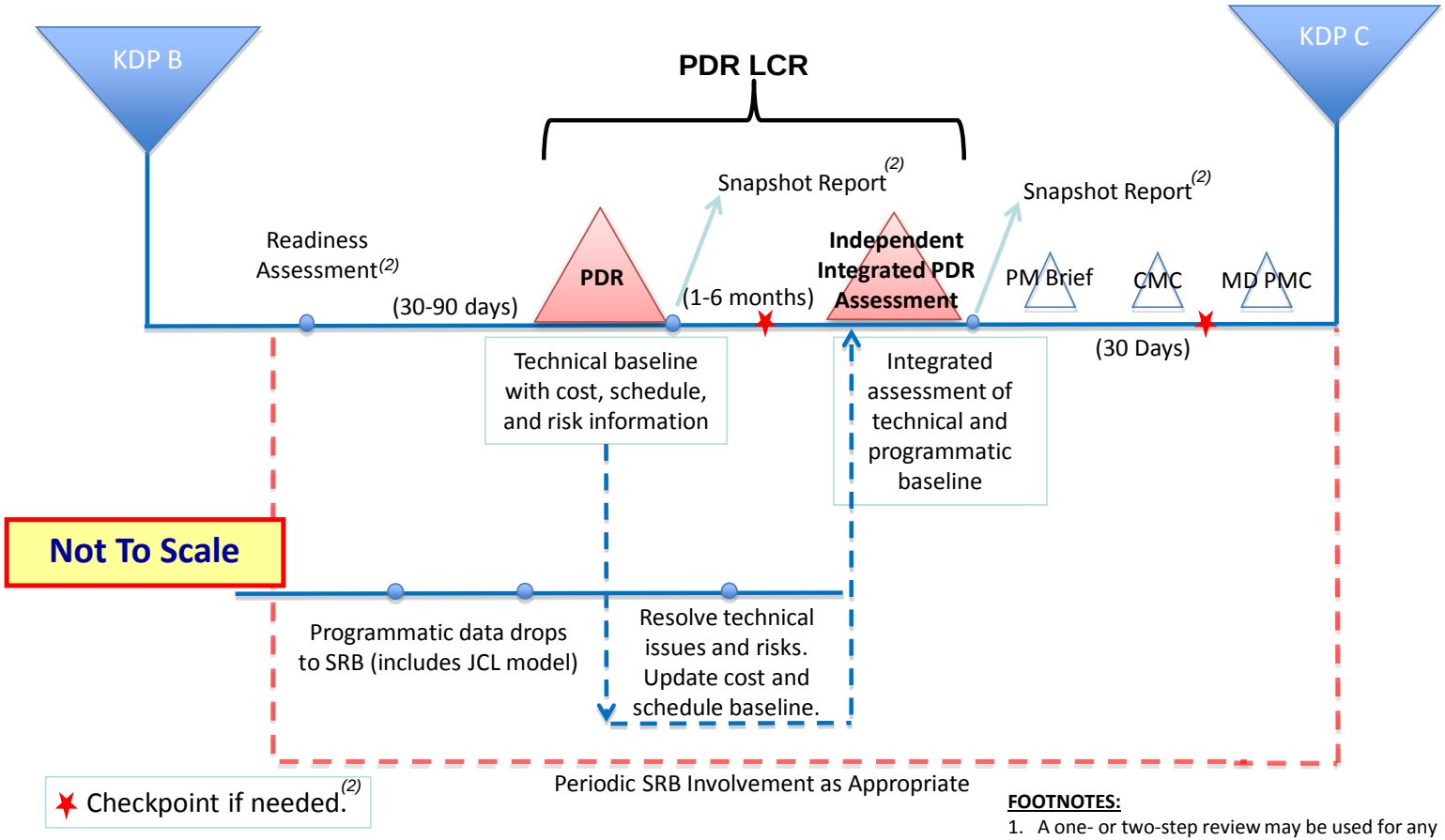


Figure 2-6 One-Step PDR Life Cycle Review Overview

Two-Step[1] PDR Life Cycle Review Overview (Example)



FOOTNOTES:

1. A one- or two-step review may be used for any life cycle review.
2. The SRB Handbook provides information on the readiness assessment, snapshot reports, and checkpoints associated with life cycle reviews.

Figure 2-7 Two-Step PDR Life Cycle Review Overview

2.5.6.2 **Readiness Assessment.** The program or project manager, with assistance from the Mission Directorate and Technical Authorities, determines when the program or project will be ready for the life cycle review. As a prerequisite for scheduling the review, a readiness assessment is conducted to ensure that the program/project is likely to reach the required state of maturity by the proposed date(s) for the review. For a two-step review, this refers to the second step of the review. In this "conversation," the program/project manager, the SRB chair, and the Center Director (or designated Engineering Technical Authority representative) discuss the program/project's maturity with respect to entry criteria, gate products, and the expected states of maturity described in this document. In a situation where the assessment results in disagreement between the SRB chair and the program or project manager, the disagreement is reported to the Decision Authority, who then decides whether to proceed with the review. When the program/project manager judges that extenuating circumstances warrant proceeding with the life cycle review, even though some maturity expectations will not be met by the time of the review, the program/project manager is responsible for providing adequate justification for holding the life cycle review on the recommended date to the Decision Authority.

Table 2-3 Major Program/Project Reviews Not Necessarily Conducted by the SRB

The ASM
If the Mission Concept Review (MCR) is conducted as an internal review to support an MDAA determination of whether a viable project exists, the review is usually performed by the host Center (or the SRB when requested by the Decision Authority or host Center). If the MCR is conducted as the basis for concluding that the project is ready to proceed to KDP A, the SRB conducts the MCR.
The Safety and Mission Success Review (SMSR)
Systems Acceptance Review (SAR)
The Flight Readiness Review (FRR), Launch Readiness Review (LRR), and Post-Flight Assessment Review (PFAR) for Human Space Flight programs/projects and the Mission Readiness Review (MRR) for robotic missions at the discretion of the MDAA. (Rather than utilizing a complete Independent Review Board for these flight and mission operations reviews, the program SRB chair and project SRB chairs are included as advisory members to the flight and mission operations review boards. The SRB input is provided during the board meeting.)
For human space flight, the Post-Launch Assessment Review (PLAR) and Critical Events Readiness Review (CERR) are conducted by the Mission Management Team (MMT).For robotic missions, the extent of the SRB participation in the PLAR and CERR will be documented in the plan for reviews in the Project Plan.
Decommissioning Reviews (DRs) and Disposal Readiness Reviews (DRRs)

2.5.6.3 **One-Step Review**. A one-step review is an independent review chaired by the SRB with the exceptions noted in Table 2-3. The one-step review is referred to by the name of the life cycle review. For example, the one-step review preceding KDP C would be called the "PDR Life Cycle Review."

2.5.6.4 **Two-Step Review**. The first step of the review addresses the technical adequacy of the program's or project's technical approach (see paragraph 2.5.1c), and establishes the technical baseline informed by cost and schedule. The first step of the review is chaired by the program/project manager or a designee in accordance with Center practices and the Program/Project Plan. The first step of the review is referred to by the name of the life cycle review. For example, the first step of the review preceding KDP C is called "PDR."

2.5.6.5 The second step of the review occurs no later than six months after the first step of the review and addresses all criteria identified in Section 2.5.1. The second step of the review is an independent review chaired by the SRB with exceptions noted in Table 2-3. This part of the review is referred to as the Independent Integrated life cycle review assessment. For example, the second step of a two-step life cycle review preceding KDP C would be called the "Independent Integrated PDR Assessment." The two steps combined are referred to collectively by the name of the life cycle review. For example, the combined first and second steps of the review preceding KDP C are called "PDR Life Cycle Review."

2.5.6.6 **Snapshot Reports.** The SRB chair provides a summary of his/her preliminary findings to the Decision Authority within 48 hours. The program or project manager responds to the findings and describes plans for significant decisions, activities and commitments prior to the second step of the review (in the case of a two-step review) or prior to the KDP. If the estimated time to the second step of the review is greater than six months, or the estimated time to the KDP is significantly greater than 30 days, a Checkpoint is required. If a Checkpoint is not required, the Decision Authority provides interim authorization for the program's/project's plans, or directs changes.

2.5.6.7 **Checkpoints.** The program/project manager describes to the Decision Authority the detailed plans for significant decisions, activities, and commitments prior to the second step of the review (in the case of a two-step review) or prior to the KDP. The Decision Authority provides interim authorization for the program's/project's plans, or directs changes.

2.5.7 The SRB is charged with the responsibility of making an independent assessment of a program or a project at a life cycle review (with the exception of those listed in Table 2-3) and providing their assessment to the Decision Authority within 30 days of the end of the review in a formal report and briefings with findings of fact and recommendations. The SRB's assessment is developed with respect to expected maturity states in tables F-1, F-2, and F-3. The SRB works with the program or project to determine the depth of information necessary to perform that assessment. The SRB does not have authority over any program/project content.

2.5.8 The SRB has a single chairperson and a NASA Review Manager (RM)[13]. The chairperson and the RM are approved or concurred with by the same individuals who convene the life cycle reviews. (See Table 2-4.) The Associate Administrator for IPAO assigns the RM for programs and Category 1 and 2 projects that have a life cycle cost of greater than $250 million. The RM for Category 2 projects less than $250 million and Category 3 projects is assigned by the Engineering Technical Authority (ETA). The chairperson, with support from the RM, organizes the SRB and submits the names of proposed board members to the same individuals who convened the life cycle review for approval or concurrence.

[13] The NASA RM may come from JPL.

Table 2-4 Convening Authorities for Standing Review Board

	Decision Authority		Technical Authority		Director, Office of Evaluation
	NASA AA	MDAA	NASA CE	Center Director(s)	
Programs	Approve	Approve	Approve	Approve	Approve
Category 1 Projects	Approve	Approve	Concur	Approve	Approve
Category 2 Projects		Approve	Concur	Approve	Approve*
Category 3 Projects		Approve		Approve	

NASA CE = NASA Chief Engineer

* Only for Category 2 projects that are greater than $250 million.

NOTE: LCR entrance and success criteria in Appendix G of NPR 7123.1 and the life cycle phase and KDP information in this handbook provide specifics for addressing the expected maturity state.

2.5.9 For programs and Category 1 and 2 projects (greater than $250 million), board members responsible for assessing the program's or project's cost and schedule are provided by the Independent Program Assessment Office (IPAO). For Category 2 projects less than $250 million and Category 3 projects, board members responsible for independent assessments of cost and schedule may be provided by the IPAO, the Center Systems Management Office (SMO), or Center systems management function, as appropriate.

2.5.10 The SRB remains intact, with the goal of having the same core membership for the duration of the program or project, although it may be augmented over time with specialized reviewers, as needed. Board members are competent, current, and independent from the management chain of the program/project, with membership balanced between the host Center and other organizations to ensure the needs of the convening authorities are met. The Center Director needs SRB members with sufficient specific systems and technical expertise to ensure the project's detailed technical design and technical implementation is being executed in accordance with best Center practices. In addition, the MDAA needs SRB members who focus on the ability to achieve the mission objectives within the resource constraints, while evaluating the program or project from the Agency perspective, rather than the Center perspective. As a result, all individuals selected to serve on SRBs are expected to be highly qualified and to have the ability to make a broad assessment of the implementation of the program or project, which employs numerous engineering and other disciplines. The nomination and vetting process ensures these needs are met while satisfying the Agency-level need to have an informed, independent recommendation to the Decision Authority at key milestones and decision points. This process also demonstrates to external stakeholders that the SRB is independent. In cases of reimbursable programs or projects, SRB membership will be determined based on the NASA-to-sponsor agreements for the work being performed. (The criteria of competent, current, and independent still apply.) The *NASA Standing Review Board Handbook* was written to provide guidance for the development of the SRB and its membership. It can be found in the "Other Policy Documents" section of the NODIS library.

2.5.10.1 There are three allowable structures for the SRB: a Civil Service Board (CS), a Civil Service Board with expert support (CS2), or a Non-Consensus Board (NC). The key attributes of each form of SRB are delineated in Table 2-5. The option selected is based on the needs of the program or project and is documented in the ToR.

Table 2-5 SRB Structure

Option	**CS**	**CS2**	**NC**
Description	Civil Service (CS) Consensus Board—No Expert Support	Civil Service Consensus Board with Expert Support	Non-Consensus Mixed Board
SRB Chair	CS	CS	Either CS or non-CS
SRB Review Manager	CS or JPL*	CS or JPL*	CS or JPL*
SRB Composition	CS Only	CS Only; Experts provide analyses to SRB	Either CS or non-CS
SRB Product	SRB produces a report and briefings with findings of fact and recommendations; RFAs (or equivalent) from individual members**; chair briefs report.	SRB produces report and briefings with findings of fact and recommendations; RFAs (or equivalent) from any individual**; reports from individual experts**; chair briefs SRB report.	Review manager assists the chair in assembling the report based on inputs and RFAs from all individuals**; chair briefs personal findings and recommendations.
Minority Report	Minority reports documented in SRB report and in RFAs.	Minority reports documented in SRB report and RFAs.	No minority report.***
SRB Interaction	For CS and CS2 boards, as noted: Consensus is reached by the Civil Service board members under the civil service consensus (CS) and the civil service with consult support (CS2) SRB configurations. Consultants (non-board members) supporting CS2 boards may interact with the projects or programs on behalf of the SRB members to gather information used to support SRB non-deliberative discussions. For all board options: All board members may participate in open discussion with the project and within the SRB. Each may openly discuss individual points of view.		
Independence	Normal CS ethics rules apply.	Experts providing support are not on the SRB. Apply independence standards to experts. CS ethics rules apply.	Apply independence standards to experts but allow some impairments, if approved.

Option	CS	CS2	NC
Description	Civil Service (CS) Consensus Board—No Expert Support	Civil Service Consensus Board with Expert Support	Non-Consensus Mixed Board
* JPL review managers are not members and do not have a vote. ** Reports and RFAs can contain individual recommendations. *** The minority report requirements do not abridge NASA's Dissenting Opinion process per NPD 1000.0.			

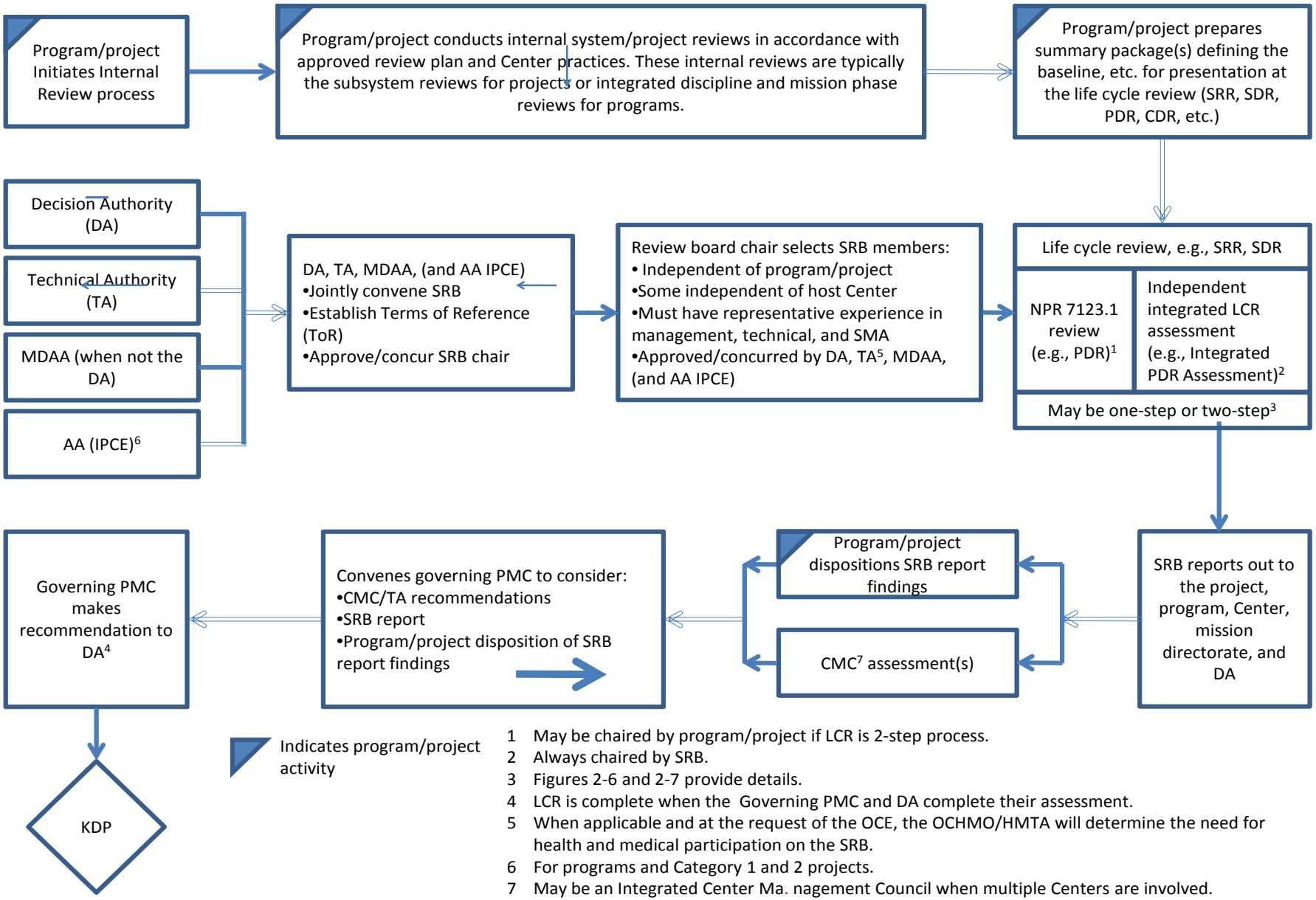
2.5.11 To maintain the integrity of the independent review process and the SRB reports and to comply with federal law, the Conflict of Interest (COI) procedures detailed in the *NASA Standing Review Board Handbook* are to be strictly adhered to. The basic principle is that SRB members are free and remain free of financial or other conflicts of interest. Conflicts of interest may be personal, based on the personal interests of the individual (Personal Conflict of Interest (PCI)) or organizational, based upon the interests of the individual's employer (Organizational Conflict of Interest (OCI)). However, nothing in this section authorizes the convening authority or Decision Authority to make determinations required by or reserved for another official by statute, regulation, or NASA directive.

2.5.12 Figure 2-8 provides an integrated perspective of the overall program/project life cycle review process from the program/project internal reviews and formulation of the SRB to the LCR and completion of the KDP.

2.5.13 The Office of the Administrator, MDAA, or the Technical Authority also may convene special reviews as they determine the need. Circumstances that may warrant special reviews include an expectation of programs or projects not meeting technical, cost, or schedule requirements; an inability to develop an enabling technology; or some unanticipated change to the program or project baseline. In these cases, the MDAA or the Technical Authority forms a special review team composed of relevant members of the SRB and additional outside expert members, as needed. The MDAA or the Technical Authority provides the chair of the review with the ToR for the special review. The process followed for these reviews is the same as for other reviews. The special review team is dissolved following resolution of the issue(s) that triggered its formation.

2.5.14 Rebaseline reviews (see Section 2.4.3) are conducted when the Decision Authority determines the ABC needs to be changed. Rebaseline reviews are conducted by the SRB and revisit the gate products required for PDR/KDP C.

2.5.15 NASA Headquarters SMA has a process that provides independent compliance verification for the applicable NASA SMA process and technical requirements within the program or project safety and mission assurance plan, the program baseline requirements set, and appropriate contract documentation.



1 May be chaired by program/project if LCR is 2-step process.
2 Always chaired by SRB.
3 Figures 2-6 and 2-7 provide details.
4 LCR is complete when the Governing PMC and DA complete their assessment.
5 When applicable and at the request of the OCE, the OCHMO/HMTA will determine the need for health and medical participation on the SRB.
6 For programs and Category 1 and 2 projects.
7 May be an Integrated Center Ma. nagement Council when multiple Centers are involved.

Figure 2-8 Program/Project Independent Life Cycle Review Process

2.5.16 If the Decision Authority is considering terminating a program or project in phases C, D, or E, then a special termination KDP may be initiated. Circumstances, such as the anticipated inability of the program or project to meet its commitments, an unanticipated change in Agency strategic planning, or an unanticipated change in the NASA budget, may be instrumental in triggering a termination KDP. For Category 2 and 3 projects, the Decision Authority notifies the NASA AA at least 45 days (Category 2 projects) or 21 days (Category 3 projects) in advance of a termination KDP. For programs and Category 1 projects, the MDAA provides recommendations to the Decision Authority on the need for a termination KDP. The Decision Authority commissions an independent assessment and, following its completion, the governing PMC holds a Termination Review. For operating missions, terminations are handled in accordance with NPD 8010.3, *Notification of Intent to Decommission or Terminate Operating Space Systems and Terminate Missions*.

2.5.17 At the Termination Review, the program and the project teams present status, including any material requested by the Decision Authority. A Center Technical Authority (see Section 3.5) presents an assessment at the program or project level, or an OCE assessment is presented by the Technical Authority for tightly coupled programs with multiple Centers implementing the projects. Appropriate support organizations are represented (e.g., procurement, external affairs, legislative affairs, chief financial officer, and public affairs), as needed. The decision and the basis for the decision are fully documented and reviewed with the NASA AA prior to final implementation.

2.6 Use of Earned Value Management

2.7.1 Earned value management (EVM) planning begins during Formulation and is applied to programs at the discretion of the MDAA, and in phases C and D, to NASA projects for which the life cycle cost is estimated to be greater than $20 million. EVM also is applied when modifications, enhancements, or upgrades are made during Phase E when the estimated development cost is greater than $20 million. Each applicable project uses an EVM system that complies with the guidelines in ANSI/EIA-748, *Standard for Earned Value Management Systems*, and the system is described in the Project Plan.

2.6.1.1 Each project flows down EVM system requirements to appropriate suppliers and to in-house work elements. (See Appendix A for a definition of "suppliers.") NFS 1834 is applied to contractors and subcontractors. Integrated Baseline Reviews (IBRs) are conducted as required and completed before the PDR life cycle review, if appropriate.[14] Contract EVM reporting begins no later than 90 days after contract award.

2.7.1.2 The project will conduct a pre-approved integrated review of project baselines as part of their preparations for KDP C to ensure that the project's work is properly linked with its cost, schedule, and risk, and that the management processes are in place to conduct project-level EVM. The project's Performance Measurement Baseline (PMB)[14] is established in Phase B in

[14] For some projects, a series of IBRs on the individual contracts and other project activities are necessary to accommodate different schedules for these various project elements. The approved baselines from the individual IBRs, combined with any project level-of-effort and in-house areas, are considered the equivalent of the project PMB.

preparation for KDP C approval. Project EVM reporting begins no later than 60 days after the start of Phase C.

Chapter 3. Program and Project Management Roles and Responsibilities

3.1 Governance

3.1.1 The fundamental principles of NASA governance are defined in NPD 1000.0, NASA Governance and Strategic Management Handbook. The governance model prescribes a management structure that employs checks and balances among key organizations to ensure that decisions have the benefit of different points of view and are not made in isolation. This structure is made up of two authorities: Programmatic and Institutional. Programmatic Authority consists of the Mission Directorates and their respective programs and projects. The Institutional Authority consists of those organizations not in the Programmatic Authority. As part of Institutional Authority, NASA established the Technical Authority process as a system of checks and balances to provide independent oversight of programs and projects in support of safety and mission success through the selection of specific individuals with delegated levels of authority. Individuals with these formal delegations are Technical Authorities.

3.2 Roles and Responsibilities

3.2.1 The roles and responsibilities of NASA management are defined in NPD 1000.0, *NASA Governance and Strategic Management Handbook*, and further outlined in NPD 1000.3, *The NASA Organization*. The key roles and responsibilities specific to programs and projects can be summarized as follows:

a. The Administrator leads the Agency and is accountable to the President for all aspects of the Agency's mission, including establishing and articulating the Agency's vision and strategic priorities and ensuring successful implementation of supporting policies, programs, and performance assessments. The Administrator performs all necessary functions to govern NASA operations and exercises the powers vested in NASA by law.

b. The NASA Associate Administrator is responsible for the technical and programmatic integration of programs at the Agency level; and serves as the Decision Authority for programs and Category 1 projects with the advice of the APMC. He or she monitors the status and performance of the programs and projects via reports from the MDAA and through Agency-level review, such as the APMC and the Baseline Performance Review (BPR) process. The NASA AA may delegate Decision Authority to MDAAs.

c. Mission Directorate Associate Administrators are responsible for Programmatic Authority in managing programs and projects within their Mission Directorate. They establish directorate policies applicable to programs, projects, and supporting elements; support the Agency's strategic acquisition process; initiate new programs and projects; recommend assignment of programs and Category 1 projects to Centers; assign Category 2 and 3 projects to Centers; serve as the KDP Decision Authority for Category 2 and 3 projects; are responsible for all program-level requirements; establish program and project budgets; approve Formulation Agreements and Program and Project Plans; oversee program and project performance via the MD PMC; and approve launch readiness. The MDAAs may delegate some of their Programmatic Authority to deputy

associate administrators, division directors, or their equivalent, such as program directors, and Center Directors. The MDAAs proactively work with Center Directors to develop constructive solutions for the formulation and implementation of programs and projects conducted at their Centers and to resolve issues as they arise.

d. Center Directors are responsible for both Institutional Authority responsibilities and execution of programs and projects assigned to the Center. They are responsible for:

(1) Institutional Authority Role: This includes ensuring that program/project teams at their Center accomplish their goals in accordance with the prescribed requirements and the Agency's and Center's procedures and processes. In accomplishing this role, Center Directors are delegated Technical Authority in accordance with Section 3.3 of NPR 7120.5 and concur in the Center's Technical Authority implementation plan. They establish and maintain ongoing processes and forums, including the Center Management Council, to monitor the status and progress of programs and projects at their Center and to provide a summary status at the BPR and other suitable venues. They periodically review programs and projects to ensure they are performing in accordance with their Center's and the Agency's requirements, procedures, processes, etc. They keep the Decision Authority advised of the executability of all aspects of their programs and projects (programmatic, technical, and all others) along with major risks, mitigation strategies, and significant concerns. They concur in the adequacy of cost/schedule estimates and the consistency of these estimates with Agency requirements, workforce, and other resources stipulated in proposed Program and Project Plans; certify that programs and/or projects have been accomplished properly as part of the launch approval process; and ensure that Center training and certification programs for program and project managers are in place and that program and project managers have met the training requirements.

(2) Role in Execution of Programs and Projects: This includes ensuring the Center is capable of accomplishing the programs, projects, other activities assigned to it in accordance with Agency policy and the Center's best practices and institutional policies by establishing, developing, and maintaining institutional capabilities (processes and procedures, human capital—including trained/certified program/project personnel, facilities, and infrastructure) required for the execution of programs and projects; and working with the Mission Directorate and the programs and project managers, once assigned, to assemble the program/project team(s) to accomplish the program or project. This role includes supporting the program and projects by providing needed Center resources and support and guidance to programs and projects in resolving technical and programmatic issues and risks; monitoring the technical and programmatic progress of programs and projects to help identify issues as they emerge; proactively working with the Mission Directorates, programs, projects, and other Institutional Authorities to find constructive solutions to problems; and proactively working on cross-Center activities to benefit both the programs' and projects' and the overall Agency's long-term health.

e. The program manager is responsible for the formulation and implementation of the program as described in NPR 7120.5 and NPR 7123.1. This includes responsibility and accountability for the program safety; technical integrity; technical, cost, and schedule performance; and mission success.

f. The project manager is responsible for the formulation and implementation of the project as described in NPR 7120.5 and NPR 7123.1. This includes responsibility and accountability for the project safety; technical integrity; technical, cost, and schedule performance; and mission success.

g. The Director, IPAO, is responsible for enabling independent review (an unbiased, objective review of the maturity, health, and status) of the Agency's programs and projects at life cycle milestones to ensure the highest probability of mission success. The IPAO ensures the objectivity, quality, integrity, and consistency of the independent review process.

h. The NASA Chief Engineer establishes policy, oversight, and assessment of the NASA engineering and program/project management processes; implements the Engineering Technical Authority process; and serves as principal advisor to the Administrator and other senior officials on matters pertaining to the technical capability and readiness of NASA programs and projects to execute according to plans. The chief engineer directs the NASA Engineering and Safety Center (NESC) and ensures that programs/projects respond to requests from the NESC for data and information needed to make independent technical assessments and then respond to NESC assessments. The chief engineer leads the mission and program/project performance assessment for the BPR; ensures that space asset protection functional support is provided to NASA missions and management, including at a minimum, preparation of program threat summaries and project protection plans; and co-chairs the SMSR with the Office of Safety and Mission Assurance (OSMA).

i. The Chief, Safety and Mission Assurance ensures the existence of robust safety and mission assurance processes and activities through the development, implementation, assessment, and functional oversight of Agency-wide safety, reliability, maintainability, quality, and risk management policies and procedures; serves as principal advisor to the Administrator and other senior officials on Agency-wide safety, reliability, maintainability, and quality; performs independent program and project compliance verification audits; implements the SMA Technical Authority process; monitors, collects, and assesses Agency-wide safety and mission assurance financial and performance results; and co-chairs the Safety and Mission Success Review (SMSR) with the OCE.

j. The Chief Health and Medical Officer establishes policy, oversight, and assessment on all health and medical matters associated with NASA missions, is responsible for implementation of the Health and Medical Technical Authority process, and serves as principal advisor to the Administrator and other senior officials on health and medical issues related to the Agency workforce.

k. The Mission Support Directorate (MSD) Associate Administrator establishes policy and procedures for institutional oversight for mission support functional areas (e.g., procurement).

l. Roles and responsibilities for other NASA organizations can be found in NPD 1000.3.

3.3 Programmatic Authority

3.3.1 Programmatic Authority flows from the Administrator through the Associate Administrator to the Mission Directorate Associate Administrator, to the program manager and finally to the project manager per NPD 1000.0. Because there are different types of programs that require different management approaches, the MDAA may delegate some of his/her Programmatic Authority to Deputy Associate Administrators, division directors, or their equivalent, such as program directors, depending on the Mission Directorate organizational structure, consistent with the following principles:

a. As a general rule, the MDAA will not delegate responsibility beyond his/her immediate organization for strategic planning; policy formulation and approval; definition and approval of programs, projects, and missions; assignment of programs, projects, and selected managers; Mission Directorate budget development, approval, and allocation; and assessment and reporting of performance. Delegations will be documented to ensure roles and responsibilities are understood and accountability is clear.

b. As a minimum, the program manager is responsible and accountable for the program safety; technical integrity; technical, cost, and schedule performance; and mission success; for developing and presenting time-phased cost estimates, budget, and funding requirements; developing and implementing the program plan, including managing program resources; implementing a risk management process that incorporates Risk-Informed Decision Making (RIDM); overseeing project implementation, including resolution of project risks by such means as allocation of margins to mitigate risks; periodically reporting progress to the Mission Directorate; and supporting Mission Directorate activities.

c. The responsibilities and authority of the MDAA and those individuals with delegated Programmatic Authority are to be documented in the Program Plan such that they are unambiguous and not overlapping.The project manager reports to the program manager and both are supported by one or more NASA Centers (with facilities and experts from line or functional organizations). The project manager, however, is responsible for the formulation and implementation of the project as described in NPR 7120.5 and NPR 7123.1. This includes responsibility and accountability for the project safety, technical integrity, and mission success of the project, while also meeting programmatic (technical, cost, and schedule performance) commitments. Accomplishing this requires a breadth of skills, so he/she needs to be knowledgeable about governing laws; acquisition regulations; policies affecting program and project safety; training of direct-report personnel; risk management; environmental management; resource management; program- and project-unique test facilities; the health of the industrial base and supply chain supporting the program and project, including critical and single-source suppliers;

software management; responding to external requests for audits (e.g., OMB); protecting intellectual property and technology; and other aspects of program and project management.

3.3.2 It is important for the program and project manager to coordinate early and throughout the program or project life cycle with mission support organizations at NASA Headquarters through the sponsoring Mission Directorate and the implementing Centers. These mission support organizations include legal, procurement, security, finance, export control, human resources, public affairs, international affairs, property, facilities, environmental, aircraft operations, IT, planetary protection, and others. They provide essential expertise and ensure compliance with relevant laws, treaties, executive orders, and regulations. It is also important to ensure that organizations having a substantive interest (these might include supporting activities, such as facilities, logistics, etc.) are integrated effectively into the program's or project's activities as early as appropriate and throughout the duration of the organizations' interest to include their needs, benefit from their experience, and encourage communication.

3.4 Institutional Authority

3.4.1 The Institutional Authority consists of those organizations not in the Programmatic Authority. As shown in Figure 1-1, this includes Engineering, Safety and Mission Assurance, and Health and Medical organizations, Mission Support organizations and Center Directors. Engineering, Safety and Mission Assurance, and Health and Medical organizations are a unique segment of the Institutional Authority and are covered in Section 3.5, Technical Authority.

3.4.2 Mission Support Directorate (MSD) Associate Administrator establishes directorate policies and procedures for institutional oversight for mission support functional areas (e.g., procurement). As part of MSD, the Mission Support Offices are the "official voices" of their institutional areas and the associated requirements established by NASA policy, law, or other external mandate. Their authorities are asserted horizontally (across Headquarters) and vertically (Headquarters to Centers, and within Centers) through leadership where there is not a direct line relationship. The delegated responsibilities of Mission Support Offices vary depending on their functional areas, such as finance, procurement, information technology, legal, facilities engineering, and environmental. Common responsibilities of Mission Support Offices are to:

a. Represent the institutional function and convey respective institutional requirements established by law, Agency policy, or other external or internal authority, to program and project managers.

b. Collaborate with programmatic managers on how best to implement prescribed institutional requirements and achieve program or project goals in accordance with all statutory, regulatory, and fiduciary responsibilities.

c. Ensure conformance to institutional requirements, either directly or by agreement with other NASA organizations.

d. Disposition all requests for changes to prescribed institutional requirements in their respective area of responsibility.

3.4.3 The Center is where the execution of programs and projects takes place. As such, Centers have both execution and institutional authority responsibilities, and the Center Directors need to ensure that both of these functions operate within the governance and management structure dictated by NPD 1000.0, *NASA Governance and Strategic Management Handbook*.

3.4.3.1 As part of the execution responsibility, the Center Director is responsible for ensuring that the Center is capable of accomplishing the programs, projects, other activities assigned to it in accordance with Agency policy and the Center's best practices and institutional policies. In accomplishing this role, they:

a. Establish, develop, and maintain institutional capabilities (processes and procedures, human capital—including trained/certified program/project personnel, facilities, and infrastructure) required for the execution of programs and projects. This includes sound technical and management practices, internal controls, and an effective system of checks and balances to ensure the technical integrity of program or project activities being executed at the Center.

b. Work with the Mission Directorate and the programs and project managers, once assigned, to assemble the program/project team(s) to accomplish the program or project.

c. Support the program and projects by providing needed Center resources; providing support and guidance to programs and projects in resolving technical and programmatic issues and risks; monitoring the technical and programmatic progress of programs and projects to help identify issues as they emerge; and proactively working with the Mission Directorates, programs, projects and other Institutional Authorities to find constructive solutions to problems.

d. Proactively work on cross-Center activities to benefit both the programs and projects and the overall Agency long-term health.

3.4.3.2 As part of the institutional authority responsibility, Center Directors are responsible for ensuring that program/project teams at their Center accomplish their goals in accordance with the prescribed requirements and the Agency's and Center's procedures and processes. In accomplishing this role, Center Directors:

a. Are delegated Technical Authority in accordance with Section 3.5 and concur with the Center's Technical Authority implementation plan.

b. Establish and maintain ongoing processes and forums, including the Center Management Council, to monitor the status and progress of programs and projects at their Center and to provide a summary status at the BPR and other suitable venues.

c. Periodically review programs and projects to ensure they are performing in accordance with their Center's and the Agency's requirements, procedures, processes, etc.

d. Keep the Decision Authority advised of the executability of all aspects of their programs and projects (programmatic, technical, and all others) along with major risks, mitigation strategies, and significant concerns.

e. Concur in the adequacy of cost/schedule estimates and the consistency of these estimates with Agency requirements, workforce, and other resources stipulated in proposed Program and Project Plans.

f. Certify that programs and/or projects have been accomplished properly as part of the launch approval process.

g. Ensure that Center training and certification programs for program and project managers are in place and that program and project managers have met the training requirements.

3.5 Technical Authority

3.5.1 The NASA governance model prescribes a management structure that employs checks and balances among key organizations to ensure that decisions have the benefit of different points of view and are not made in isolation. (See NPD 1000.0.) NASA has established the Technical Authority process as part of its system of checks and balances to provide independent oversight of programs and projects in support of safety and mission success through the selection of specific individuals with delegated levels of authority. These individuals are the Technical Authorities. In this document, the term Technical Authority (TA) is used to refer to such an individual, but is also used to refer to elements of the Technical Authority process. The responsibilities of a program or project manager are not diminished by the implementation of Technical Authority. The program or project manager is ultimately responsible for the safe conduct and successful outcome of the program or project in conformance with governing requirements. This includes meeting programmatic, institutional, technical, safety, cost, and schedule commitments.

3.5.1.1 Technical Authority originates with the Administrator and is formally delegated to the NASA AA and then to the NASA Chief Engineer for Engineering Technical Authority; the Chief, Safety and Mission Assurance for SMA Technical Authority; the Chief Health and Medical Officer for Health and Medical Technical Authority; and then to the Center Directors. Subsequent Technical Authority delegations are made to selected individuals who are funded independent of the Programmatic Authority. Such delegations are formal and traceable to the Administrator. Individuals with Technical Authority are funded independent of a program or project. Technical Authorities located at Centers remain part of their Center organization, and their personnel performance appraisal is signed by the management of that Center organization. The Center Director (or designee) is responsible for establishing and maintaining Center Technical Authority policies and practices, consistent with Agency policies and standards. Nothing in the Technical Authority process is intended or should be construed to abridge or diminish the SMA powers to “suspend work” in NPD 1000.3.

3.5.2 **Other Technical Authority Roles**

3.5.2.1 Top-level documents developed by a program detailing Agency-level requirements for human-rated systems are signed by the Administrator or his/her formally delegated designee.

3.5.2.2 On decisions related to technical and operational matters involving safety and mission success residual risk, formal concurrence by the responsible Technical Authority(ies) (Engineering, Safety and Mission Assurance, and/or Health and Medical) is required. This

concurrence is to be based on the technical merits of the case. For residual risks to personnel or high-value hardware, the cognizant safety organization needs to agree that the risk is acceptable. For matters involving human safety risk, the actual risk taker(s) (or official spokesperson(s) and their supervisory chain) need to formally consent to taking the risk, and the responsible program, project, or operations manager needs to formally accept the risk.

3.5.3 At the program or project level, the responsibilities common to each of the individuals with delegated Technical Authority (ETA, SMA TA, and Health and Medical Technical Authority (HMTA)) are delineated below. (See paragraph 3.5.6.1 and paragraph 3.5.6.2 for unique aspects of individual Technical Authorities.) These individuals:

a. Serve as members of program or project control boards, change boards, and internal review boards.

b. Work with the Center management and other Technical Authority personnel, as necessary, to ensure that the quality and integrity of program or project processes, products, and standards of performance related to engineering, SMA, and health and medical reflect the level of excellence expected by the Center or, where appropriate, by the NASA Technical Authority community.

c. Ensure that requests for waivers or deviations from Technical Authority requirements are submitted to and acted on by the appropriate level of Technical Authority. ("Technical Authority requirements" are defined in Appendix A.)

d. Assist the program or project in making risk-informed decisions that properly balance technical merit, cost, schedule, and safety across the system.

e. Provide the program or project with the TA view of matters based on their knowledge and experience and raise a Dissenting Opinion (see Section 3.4) on a decision or action, when appropriate.

f. Serve as an effective part of NASA's overall system of checks and balances.

3.5.3.1 At all Centers (except JSC, where the chief medical officer serves this function), the program/project-level ETA and SMA TA are responsible to serve as the awareness and communication links for potential HMTA issues and to inform the appropriate level of HMTA, the program/project manager, and Center management of potential HMTA issues. (See NPR 7120.11.)

3.5.4 The day-to-day involvement of the Technical Authorities (TAs) in program/project activities ensures that significant views from the TAs will be available to the program or project in a timely manner and should be handled during the normal program/project processes.

3.5.5 Infrequent circumstances may arise when a Technical Authority and the program or project manager disagree on a proposed programmatic or technical action and judge that the issue rises to a level of significance that should be brought to the attention of the next higher level of management (i.e., a Dissenting Opinion exists). In such circumstances:

a. Resolution occurs prior to Implementation whenever possible. However, if considered to be in the best interest of the program/project, the program/project manager has the authority to proceed at risk in parallel with the pursuit of a resolution. In such circumstances, the next higher level of Programmatic and Technical Authority is informed of the decision to proceed at risk.

b. Resolution is jointly attempted at successively higher levels of Programmatic Authority and Technical Authority until resolved. Final appeals are made to the NASA Administrator. (See Section 3.6.)

3.5.6 The **Engineering Technical Authority** establishes and is responsible for the engineering design processes, specifications, rules, best practices, etc., necessary to fulfill programmatic mission performance requirements.

3.5.6.1 The NASA Chief Engineer provides overall leadership for the Engineering Technical Authority process for programs and projects, including Agency engineering policy direction, requirements, and standards. The NASA Chief Engineer approves the appointment of the Center engineering directors (or equivalent) and of Engineering Technical Authorities on programs and Category 1 projects and is notified of the appointment of other Engineering Technical Authorities. The NASA Chief Engineer hears appeals of engineering decisions when they cannot be resolved at lower levels.

3.5.6.2 The Center Director (or designee) develops the Center's Engineering Technical Authority (ETA) policies and practices, consistent with Agency policies and standards. The following individuals are responsible for implementing Engineering Technical Authority at the Center:

a. Center Director—The Center Director (or the Center Engineering Director or designee) is the Center Engineering Technical Authority responsible for Center engineering design processes, specifications, rules, best practices, etc., necessary to fulfill mission performance requirements for programs, projects and/or major systems implemented by the Center. (The Center Director may delegate Center Engineering Technical Authority implementation responsibility to an individual in the Center's engineering leadership.) The Center Engineering Technical Authority supports the Technical Authorities in processing changes to and waivers or deviations from requirements that are the responsibility of the Engineering Technical Authority. This includes all applicable Agency and Center engineering directives, requirements, procedures, and standards. The Center Director appoints, with the approval of the NASA Chief Engineer, individuals for the position of Center engineering director (or equivalent) and for the Engineering Technical Authority positions down to and including program chief engineers and Category 1 project chief engineers (or equivalents).[15] The Center Director appoints Category 2 and 3 project chief engineers and lead discipline engineers.

[15] Centers may use an equivalent term for these positions, such as Program/Project Systems Engineer.

b. Program/Project Chief Engineer (PCE)—The PCE is the position to which the program- or project-level Engineering Technical Authority has been delegated. Different Centers use different titles for this position.

c. Lead Discipline Engineer (LDE)—The LDE is a senior technical engineer in a specific discipline at the Center. Different Centers use different titles for this position. The LDE assists the program/project through direct involvement with working-level engineers to identify engineering requirements in accordance with NPR 7120.10, *Technical Standards for NASA Programs and Projects*, and other documents and develops solutions that comply with the requirements. The LDE works through and with the PCE to ensure the proper application and management of discipline-specific engineering requirements and Agency standards. Only those LDEs who have formally delegated Technical Authority traceable to the Administrator and are funded independent of programs and projects are Technical Authorities.

3.5.6.3 The Engineering Technical Authority for the program or project leads and manages the engineering activities, including systems engineering, design, development, sustaining engineering, and operations. A Center may have more than one engineering organization and delegates Engineering Technical Authority to different areas, as needed. To support the program or project and maintain Engineering Technical Authority independence and an effective check and balance system:

a. The program/project manager concurs in the appointment of the program/project-level Engineering Technical Authorities.

b. The Engineering Technical Authority cannot be the decision maker on a board or panel that provides relief to a derived requirement. This provision does not preclude such an Engineering Technical Authority from chairing preliminary boards that provide input to the change or control board.

c. As a minimum, two Engineering Technical Authorities (e.g., the PCE and the applicable LDE) need to agree with the action to accept a change to or a waiver or deviation from a Technical Authority requirement.

3.5.7 Although a limited number of individuals make up the Engineering Technical Authorities, their work is enabled by the contributions of the program's or project's working-level engineers and other supporting personnel (e.g., contracting officers). The working-level engineers do not have formally delegated Technical Authority and consequently may not serve in an Engineering Technical Authority capacity. These engineers perform the detailed engineering and analysis for the program/project with guidance from their Center management and/or LDEs and support from the Center engineering infrastructure. They deliver the program/project products (e.g., hardware, software, designs, analysis, and technical alternatives) that conform to applicable programmatic, Agency, and Center requirements. They are responsible for raising issues to the program/project manager, Center engineering management, and/or the PCE, as appropriate, and are a key resource for resolving these issues.

3.5.8 The **SMA Technical Authority** establishes and is responsible for the SMA processes, specifications, rules, best practices, etc., necessary to fulfill safety and programmatic mission performance requirements. (Refer to NASA-STD-8709.20, *Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements*.)

3.5.8.1 The Chief, SMA hears appeals of SMA decisions when issues cannot be resolved below the Agency level.

3.5.8.2 The Center SMA director is responsible for establishing and maintaining institutional SMA policies and practices, consistent with Agency policies and standards. The Center SMA director also is responsible for ensuring that the program or project complies with both the program/project and Center SMA requirements. The program or project SMA plan, which describes how the program or project will comply with these requirements, is part of the Program Plan or Project Plan. The Center SMA director also monitors, collects, and assesses institutional, program, and project SMA financial metrics and performance results.

3.5.9 The **Health and Medical Technical Authority** is the NASA Chief Health and Medical Officer (CHMO). The CHMO establishes and is responsible for the health and medical Agency-level requirements, specifications, rules, best practices, etc., necessary to fulfill programmatic mission performance requirements.

3.5.9.1 Due to Center infrastructure differences, the flow down of HMTA processes and responsibilities from the CHMO varies between Centers. Additionally, the CHMO entered into an agreement with SMA and OCE to have engineering and safety Technical Authority personnel serve as awareness and communication links for HMTA. The HMTA flow-down and communication processes, including roles and responsibilities, are specified in NPR 7120.11, *Health and Medical Technical Authority Implementation*, and further described in the Center HMTA implementation plan. NPR 7120.5 recognizes that medical staff have a special obligation to protect the handling and dissemination of an individual's medical information. These restrictions need to be respected.

3.5.9.2 When applicable, the Program Plan or Project Plan will describe how the program or project will comply with HMTA requirements and processes as described in NPR 7120.11. The CHMO hears appeals of HMTA decisions when issues cannot be resolved below the Agency level.

3.6 Process for Handling Dissenting Opinions

3.6.1 NASA teams need to have full and open discussions, with all facts made available, to understand and assess issues. Diverse views are to be fostered and respected in an environment of integrity and trust with no suppression or retribution. In the team environment in which NASA operates, team members often have to determine where they stand on a decision. In assessing a decision or action, a member has three choices: agree, disagree but be willing to fully support the decision, or disagree and raise a Dissenting Opinion. For disagreements that rise to the level of importance to warrant a specific review and decision by a higher level of management, NASA has formalized the Dissenting Opinion process. (Additional considerations that relate to

Dissenting Opinions raised by a Technical Authority are explained in more detail in NPD 1000.0, and in Section 3.4 of NPR 7120.5.)

3.6.2 Unresolved issues of any nature (e.g., programmatic, safety, engineering, health and medical, acquisition, accounting) within a team should be elevated quickly to achieve resolution at the appropriate level. A Dissenting Opinion is a substantive disagreement with a decision or action that an individual judges is not in the best interest of NASA and is of sufficient importance that it warrants a timely review and decision by higher level management. A Dissenting Opinion must be supportable and based on a sound rationale (not solely on unyielding opposition). The individual must specifically request that the dissent be recorded and resolved by the Dissenting Opinion process. The decision whether the issue in question is of the significance that warrants the use of the Dissenting Opinion process is the responsibility and personal decision of the dissenting individual.

3.6.3 When time permits, the disagreeing parties jointly document the issue, including agreed-to facts, discussion of the differing positions with rationale and impacts, and the parties' recommendations. The joint documentation needs to be approved by the representative of each view, concurred with by affected parties, and provided to the next higher level of the involved authorities with notification to the second higher level of management. This may involve a single authority (e.g., the Programmatic Authority) or multiple authorities (e.g., Programmatic and Technical Authorities). In cases of urgency, the disagreeing parties may jointly present the information stated above orally with all affected organizations represented, advance notification to the second higher level of management, and documentation follow up.

3.6.4 Management's decision on the dissent memorandum (or oral presentation) is documented and provided to the dissenter and to the notified managers and becomes part of the program or project record. If the dissenter is not satisfied with the process or outcome, the dissenter may appeal to the next higher level of management. The dissenter has the right to take the issue upward in the organization, even to the NASA Administrator, if necessary.

3.7 Principles Related to Tailoring Requirements

3.7.1 It is NASA policy to comply with all prescribed directives, requirements, procedures, and processes unless relief is formally granted in accordance with the principles related to tailoring requirements delineated in this section. Tailoring is the process used to adjust or seek relief from a prescribed requirement to accommodate the needs of a specific task or activity (e.g., program or project). The evaluation and disposition of requests for tailoring prescribed requirements (including Agency-level requirements and standards) complies with the following:

a. The organization at the level that established the requirement approves the request for tailoring of that requirement unless this authority has been formally delegated elsewhere. The organization approving the tailoring disposition consults with the other organizations that were involved in the establishment of the specific requirement and obtains the concurrence of those organizations having a substantive interest.

b. The involved management at the next higher level is informed in a timely manner of the request for tailoring of a prescribed requirement.

3.7.1.1 The tailoring process results in the generation of "deviations" or "waivers," depending on the timing of the request. The following definitions apply:

a. Deviation—A documented authorization releasing a program or project from meeting a requirement *before* the requirement is put under configuration control at the level the requirement will be implemented.

b. Waiver—A documented authorization releasing a program or project from meeting a requirement *after* the requirement is put under configuration control at the level the requirement will be implemented.

3.7.1.2 A prescribed requirement that is not relevant and/or not capable of being applied to a specific program, project, system or component is identified as Non-Applicable. A Non-Applicable categorization can be approved by the individual who has been delegated oversight authority by the organization that established the requirement. This approval can be granted at the level where the requirement was specified for implementation (e.g., the project-level ETA could approve a Non-Applicable designation for an engineering requirement). The request and approval documentation become part of the retrievable program or project records. No other formal deviation or waiver process is required.

3.7.2 A request for a permanent change to a prescribed requirement in an Agency or Center document that is applicable to all programs and projects is submitted as a "change request" to the office responsible for the requirements policy document unless formally delegated elsewhere.

3.7.2.1 To assist in the expeditious processing of requests for relief from a prescribed requirement and to support requirement tracking, the attributes and data needed for tracking, which follow in tables 3-1 and 3-2, are to be included in requests. The specific format or form in which the attributes and tracking data are submitted is the responsibility of the requesting activity, but must be useable by the receiving organization. Additional process, requirements, and required data elements for requesting tailoring of Agency-level SMA TA requirements can be found in NPR 8715.3, *NASA General Safety program Requirements* and NASA-STD-8709.20.

Table 3-1 Minimum Attributes for Requests for Requirement Relief

Descriptive title and date for requirement relief request.	Unique identifier for the source of requirement relief request.
Name of Center, program, project, and contractor involved in request, as applicable.	Activity responsible for request (include contact information).
Complete identification of requirement for which relief is requested.	Description of the requirement(s), specification(s), drawing(s), and other baselined configuration, documentation, or product(s) affected due to this request.
Description of the scope, nature, and duration of this request (e.g., identification of the system, parts, heat, lot, or serial numbers).	Identify other organizations, systems, or components that may be affected.
Justification for acceptance and reference to all material used to support acceptance.	If appropriate, description of, or reference to, the corrective action taken or planned to prevent future recurrence.
Risk evaluation.	If acceptance increases risk, identify the names with signatures of the Technical Authority(ies) who has(have) agreed that the risk has been properly characterized and is acceptable and the names with signatures of the programmatic authority(ies) who has(have) agreed to accept the additional risk.

Table 3-2 Tracking Data

Requirement originates from: • NPR, NPD, NID, CPR, CPD, CPC, Center Work Instructions (CWI) • Mandatory Technical Standard • Non-Mandatory Technical Standard • Other/don't know (specify)	Rating (to be defined by the program/project/activity and properly documented): • Critical • Major • Minor • Additional information is attached
Type: • Non-Applicable (not relevant or not capable of being applied) • Technically equal or better • Requires acceptance of additional risk • Involves non-conforming product • Involves non-compliant requirement	Other: • Permanent requirement relief • Temporary requirement relief • Recurring request for relief • There is a need for corrective action to prevent recurrence
Notes: All characteristics that apply are to be checked Center, program, project may break the specified categories into additional logical sub-categories while preserving the standard check boxes Center, program, project may recommend to the NASA Chief Engineer additional standard check boxes at any time	

3.7.3 Waivers or deviations from NPR 7120.5 requirements may be granted by the officials shown in Table 3-3, unless formally delegated elsewhere. Recommended waivers and deviations to NPR 7120.5 may be submitted individually or in groups. Recommended tailoring may also be submitted in existing Formulation Agreements (for those that occur in Formulation), Program or Project Plans, or equivalent documentation as part of the normal approval process, provided the required signatures are obtained. Tailoring of the product deliverables required in the Product Maturity Tables in NPR 7120.5E is expected since, as a minimum, there are products that will not be applicable to every program or project. To request tailoring for products required by other NASA NPDs or NPRs or Federal regulations, as indicated in the Compliance Matrix in NPR 7120.5E, program or project managers, Center Directors, and MDAAs are responsible for ensuring the responsible Institutional Authority agrees to the proposed change or deletion.

Table 3-3 Waiver or Deviation Approval for NPR 7120.5 Requirements

	Project Manager	Program Manager	Center Director	MDAA	Chief Engineer	NASA AA	Approval Authority for Waivers or Deviations with Dissent
Programs		R	C**	R	A	I	NASA AA
Category 1, 2, and 3 Projects	R	R	C**	R	A	I	NASA AA
Reimbursable Space Flight Projects	R		C**	R*	A	I	NASA AA

R = Recommends, C = Concurs; A = Approves;, I = Informed
* As applicable
** Unless otherwise delegated

3.8 Center Reimbursable Space Flight Work

3.8.1 A Center negotiating Reimbursable Space Flight Work with another agency needs to propose NPR 7120.5 as the basis by which it will perform the space flight work. If the sponsoring agency does not want NPR 7120.5 requirements (or a subset of those requirements) to be followed, then the interagency Memorandum of Understanding/Memorandum of Agreement (MOU/MOA) or the contract needs to explicitly identify those requirements that will not be followed, along with the substitute requirements for equivalent processes and any additional program or project management requirements the sponsoring agency wants. The Center needs to obtain a formal waiver by the NASA Chief Engineer for those NPR 7120.5 requirements that are not to be followed or the Center cannot accept the work.

3.9 International System of Units

3.9.1 The International System of Units (commonly known as the *Système Internationale* (SI) or metric system of measurement) is to be used for all new space flight projects and programs, especially in cooperative efforts with International Partners. Public Laws 94-168 and 100-418 and Executive Order 12770 provide relief from this preferential use of SI if it is found that obtaining components in SI units would result in a substantial increase in cost or unacceptable delays in schedule. Each project needs to perform and document an assessment to determine an approach that maximizes the use of SI. This assessment will document an integration strategy if both SI and U.S. customary units are used in a project or program. The assessment is to be completed and documented in the Program Plan or Project Plan no later than the SDR.

Chapter 4. Program and Project Activities by Phase

4.1 Programs—Formulation Phase

4.1.1 The purpose of program Formulation activities is to establish a cost-effective program that is demonstrably capable of meeting Agency and Mission Directorate goals and objectives. The program Formulation Authorization Document (FAD) authorizes a program manager to initiate the planning of a new program and to perform the analyses required to formulate a sound Program Plan. Major reviews leading to approval at KDP I are the Acquisition Strategy Meeting (ASM), the Program/System Requirements Review (SRR), the Program/System Definition Review (SDR), the governing PMC review, and, for tightly coupled programs, the Preliminary Design Review (PDR). In addition, at the discretion of the Decision Authority, a KDP 0 may be required to ensure that major issues are understood and resolved prior to KDP I. The objectives for SRR, SDR and PDR, and the expected maturity states for these LCRs, KDP 0 and KDP I are provided in Table F-1 (for uncoupled and loosely coupled programs) and Table F-2 (for tightly coupled programs). For loosely coupled and uncoupled programs, all milestone products should be baselined when the Program Plan is baselined at SDR.

4.1.2 During program Formulation, the program manager and the program team:

a. For all programs:

(1) Gather and document key external stakeholder expectations, needs, goals, and objectives.

(2) Support the MDAA in developing and obtaining approval of the FAD, Program Commitment Agreement (PCA), and appropriate annual budget submissions.

(3) Support the MDAA in ensuring alignment of the program-level requirements with applicable Agency strategic goals and Mission Directorate requirements and constraints.

(4) Document the traceability of program-level requirements on individual projects to Agency strategic goals and outcomes as described in the NASA strategic and performance plans. Select technical standards products in accordance with NPR 7120.10, *Technical Standards Products for NASA Programs and Projects*.

(5) Plan, prepare for, and support the ASM prior to partnership commitments and obtain the ASM minutes.

(6) Support the MDAA and the NASA Headquarters Office of External Relations in obtaining approved interagency and international agreements (including the planning and negotiation of agreements and recommendations on joint participation in reviews, integration and test, and risk management).

(7) Support the MDAA in the selection of projects, either assigned or through a competitive process.

(8) Develop and implement the management framework, including the program team and management processes.

(9) Conduct planning that enables formulation and implementation of program and project concepts, architectures, scenarios/Design Reference Missions (DRMs), and requirements. Develop a program WBS, cost estimate, schedule, and schedule estimate. Cost and schedule should be informed by technology, engineering development and heritage assessments, acquisition strategies, infrastructure and workforce requirements, and identified risks. This includes the following:

(a) Identify and document the key ground rules and assumptions that drive development of the program and initial projects. Track status of realization, as appropriate, through Formulation.

(b) Develop the program's acquisition strategy and obtain approval including assessing, documenting, and timely reporting requirements to the MDAA; the availability of the industrial base capability and supply chain needed to design, develop, produce, and support the program and its planned projects; identifying risks associated with single source or critical suppliers; and attendant mitigation plans.

(c) Develop and document technology development plans, and initiate the development of technologies that cut across multiple projects within the program.

(d) Identify and assess significant technical and programmatic risks that drive program requirements and development. Define and document associated mitigation plans. Identify resources for managing and mitigating risks.

(e) Develop life cycle cost and schedule estimates, consistent with driving assumptions, risks, requirements, and available funding and schedule constraints.

(f) Develop JCL for tightly coupled programs.

(g) Document the basis of estimate for the cost and schedule estimates.

(h) Prepare and obtain approval of the Program Plan. (For loosely coupled and uncoupled programs, the control plans should be baselined at the time the Program Plan is baselined at SDR.) Ensure compliance with NPD 7120.4 relative to use of the International System of Units (the *Système Internationale* (SI), commonly known as the metric system of measurement) and/or any exceptions recommended by the MDAA that were granted by the NASA Chief Engineer.

(i) Approve project FADs, project Formulation Agreements, and Project Plans.

(j) Develop the program's plans for work to be performed during the Implementation Phase.

(k) Use consistent measurement units throughout all documentation to minimize risk of errors.

(l) Support the MDAA in developing and obtaining approval of any necessary Architectural Control Documents.

(10) Identify potential nonconformance to orbital debris requirements in NASA-STD-8719.14, *Process for Limiting Orbital Debris,* for planned breakups, reentry of major components that potentially could reach the surface, the planned orbital lifetime, and the use of tethers. Deviations are submitted to the Chief, SMA for approval prior to the ASM.

(11) Prepare a preliminary threat summary.

(12) Document the results of Formulation activities. Generate the appropriate documentation per NPR 7123.1. (13) Prior to the program Formulation life cycle reviews shown in figures 2-3a and 2-3b, conduct internal reviews in accordance with NPR 7123.1, Center practices, and this document.

(14) Plan, prepare for, and support the program Formulation life cycle reviews shown in figures 2-3a and 2-3b in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the LCR objectives and expected maturity states defined in Table F-1 (for uncoupled and loosely coupled programs) and Table F-2 (for tightly coupled programs).

(a) Perform an assessment of the program's readiness to proceed to SRR and SDR, and, for tightly coupled programs, to PDR.

(b) Perform an assessment with respect to the expected maturity states for SRR, SDR, and PDR (for tightly coupled programs) and KDP 0 and KDP I.

(15) Obtain KDP 0 (if required by the Decision Authority) and KDP I readiness products as listed in paragraph 2.3.7.

(16) Plan, prepare for, and support the governing PMC review prior to KDP 0 (if required by the Decision Authority) and KDP I.

b. Single project programs follow the project life cycle, but will include the draft PCA and Program Plan due at KDP B, with final versions approved by KDP C.

c. For tightly coupled programs, implement the requirements in paragraphs 4.3.2 (Pre-Phase A), 4.4.2 (Phase A), and 4.5.2 (Phase B) in the manner documented in the Program Plan (except those requirements allocated to specific projects and documented in their Project Plans).

d. Tightly coupled and single-project programs prepare a Product Data Life Cycle Management Plan in accordance with NPR 7120.9, *NASA Product Data and Life Cycle Management (PDLM) for Flight Programs and Projects,* to manage authoritative data that defines, describes, analyzes, and characterizes a product throughout its life cycle.

4.2 Programs—Implementation Phase

4.2.1 During Implementation, the program manager works with the MDAA and the constituent projects to execute the Program Plan cost effectively. Program life cycle reviews for uncoupled or loosely coupled programs ensure that the program continues to contribute to Agency and Mission Directorate goals and objectives within funding constraints. Program life cycle reviews for tightly coupled programs ensure that the program's projects are properly integrated as development and operations activities are implemented. The objectives for program life cycle reviews during program Implementation and the expected maturity states for program life cycle reviews and KDPs are provided in tables F-1 and F-2. For loosely coupled and uncoupled programs, all milestone products should be baselined at SDR.

4.2.2 During program Implementation, the program manager and the program team:

a. For all programs:

(1) Support the MDAA in ensuring continuing alignment of the program and projects with applicable Agency strategic goals, and Mission Directorate requirements and constraints.

(2) Support the MDAA in updating the PCA and Program Plan, as appropriate.

(3) Support the MDAA and the NASA Headquarters Office of External Relations in obtaining updated interagency and international agreements (including the planning and negotiation of updated agreements and recommendations on joint participation in reviews, integration and test, and risk management).

(4) Support the MDAA in the selection of projects, either assigned or through a competitive process.

(5) Execute the Program Plan. Conduct Program planning and control activities:

(a) Ensure appropriate infrastructure and trained/certified staff that cut across multiple projects within the program are available and ready when needed to support the activities of Implementation.

(b) Conduct planning, program-level systems engineering, and integration, as appropriate, to support the MDAA in initiating the project selection process.

(c) Confirm key ground rules and assumptions that drive development of the program and projects. Track status of realization, as appropriate, through Implementation.

(d) Maintain programmatic and technical oversight of the projects within the program and report their status periodically. Assist projects in the resolution of project issues, as necessary.

(e) Manage technical and programmatic margins and resources to ensure successful completion of Implementation.

(f) Maintain programmatic oversight of industrial base and supply chain issues that might pose a risk to the program or projects and provide timely notification of supply chain disruptions to the MDAA in accordance with the approved Acquisition Plan. Establish procedures to identify and manage industrial base and supply chain risks, including all critical and single-source members.

(g) Continue to develop technologies that cut across multiple projects within the program.

(h) Approve project FADs, Project Formulation Agreements, and Project Plans.

(i) Update the program's plans for work to be performed during Implementation.

(j) Update life cycle cost and schedule baselines, as needed, for any changes in the program during Implementation.

(k) Document the basis of estimate for the cost and schedule baselines, as needed, for any changes in the program during Implementation.

(l) Review and approve annual project budget submission inputs and prepare annual program budget submissions.

(m) Conduct program-level completion activities for each project in accordance with the project life cycle for Phase F (see paragraph 4.9.2).

(6) Update the program threat summary at each KDP. Update annually after launch and orbital verification of the first launch in a program unless operational necessity dictates otherwise. Finalize and archive the threat summary upon completion of the program.

(7) Document the results of Implementation activities prior to the next KDP. Generate the appropriate documentation per NPR 7123.1.

(8) Prior to the program implementation life cycle reviews shown in figures 2-3a and 2-3b, conduct internal reviews in accordance with NPR 7123.1, Center practices, and NPR 7120.5.

(9) Plan, prepare for, and support the program implementation life cycle reviews shown in figures 2-3a and 2-3b in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the LCR objectives and expected maturity states defined in Table F-1 (for uncoupled and loosely couple programs) and in Table F-2 (for tightly coupled programs).

(a) Perform an assessment of the program's readiness to proceed to the Implementation Phase LCRs.

(b) Perform an assessment with respect to the expected maturity states for the Implementation Phase LCRs and KDPs.

(10) Obtain KDP readiness products as listed in paragraph 2.3.7.

(11) Plan, prepare for, and support the governing PMC reviews prior to KDPs.

e. For single project programs:

(1) Follow the project life cycle as depicted in Figure 2-4 and detailed in Section 4.3.

f. For tightly coupled programs:

(1) For KDP II, implement the requirements in paragraph 4.6.2 (Phase C) in the manner documented in the Program Plan (except those requirements allocated to specific projects and documented in their Project Plans).

(2) For KDP III, implement the requirements in paragraph 4.7.2 (Phase D) in the manner documented in the Program Plan (except those requirements allocated to specific projects and documented in their Project Plans).

(3) For KDP IV, implement the requirements of paragraph 4.8.2 (Phase E) in the manner documented in the Program Plan (except those requirements allocated to specific projects and documented in their Project Plans).

(4) For KDP n, implement the requirements of paragraph 4.9.2 (Phase F) in the manner documented in the Program Plan (except those requirements allocated to specific projects and documented in their Project Plans).

4.3 Projects—Pre-Phase A

4.3.1 During Pre-Phase A, a pre-project team studies a broad range of mission concepts that contribute to program and Mission Directorate goals and objectives. These advance studies, along with interactions with customers and other potential stakeholders, help the team to identify promising mission concept(s) and to draft project-level requirements. A major focus of Pre-Phase A is to conduct technology and engineering systems assessments to identify risks that are likely to drive the project's cost and schedule range estimates at KDP B. The team identifies potential technology needs (based on the best mission concepts) and assesses the gaps between such needs and current and planned technology readiness levels and the technology risks. The

team also identifies engineering development risks, payload risks, supply chain risks, and heritage hardware and software risks. The team defines risk-mitigation plans and resource requirements for the top risks. These activities are focused toward the Mission Concept Review (MCR), development of the Formulation Agreement, and KDP A.

4.3.2 During Pre-Phase A, the "pre-project" manager and team:

a. Gather and document key external stakeholder expectations, needs, goals, and objectives.

b. Support the program manager and the MDAA in the development of the preliminary program requirements on the project.

c. Support the program manager and the MDAA in ensuring alignment of the project requirements with applicable Agency strategic goals.

d. Develop and implement the initial management framework, including initial project team and management processes.

e. Perform the technical activities required in NPR 7123.1 during this phase, including:

(1) Gather key internal stakeholder expectations, needs, goals, and objectives. Select technical standards products in accordance with NPR 7120.10.

(2) Develop and document at least one feasible preliminary concept including the key preliminary ground rules and assumptions that drive the concept(s).

(3) Develop initial mission objectives and requirements, and preliminary project-level requirements.

(4) Develop candidate mission, spacecraft, and ground systems architectures. Include key drivers, preliminary estimates of technical margins for candidate architectures, and a preliminary Master Equipment List.

(5) Develop an assessment of potential technology needs versus current and planned technology readiness levels, as well as potential opportunities to use commercial, academic, and other Government agency sources of technology.

(6) Develop an assessment of heritage hardware and software systems that may be utilized outside of heritage environments and configurations.

(7) Develop an assessment of preliminary technical risks for candidate architectures including engineering development risks.

(8) Develop a preliminary Systems Engineering Management Plan.

f. Conduct planning that enables formulation and implementation of the mission concept(s), architectures, scenarios/DRMs and requirements. Develop a project WBS and cost and schedule range estimates for the project through completion of Phase D (excluding Pre-

Phase A). Cost and schedule range estimates should be informed by technology needs, engineering development and heritage assessments, acquisition strategies, infrastructure and workforce requirements, and identified risks. These include the following:

(1) A high-level Work Breakdown Structure (WBS) consistent with the NASA standard space flight project WBS. (See Appendix C.)

(2) An assessment of potential infrastructure and workforce needs versus current plans, as well as opportunities to use infrastructure and workforce in other government agencies, industry, academia, and international organizations.

(3) A preliminary assessment of supply chain risks, including potential critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule.

(4) Plans for in-house work versus procurements, including major proposed procurements and types of procurements, and "no later than" procurement schedules.

(5) Preliminary plans for partners, (other government agencies, U.S. and International Partners), their roles and anticipated contributions, and plans for getting commitments for these contributions.

(6) Preliminary high technical, cost, and schedule risks, including technology development, engineering development, payload (robotic spaceflight), and procurement risks; risks associated with use of heritage hardware and software; and risks that are likely to drive the project's cost and schedule ranges at KDP B.

(7) Initial phased life cycle cost range estimate and schedule range estimate through completion of Phase D.

(8) The basis for initial cost and schedule estimates through completion of Phase D.

g. Develop the Project Formulation Agreement.

h. Document the results of Pre-Phase A activities. Generate the appropriate documentation per NPR 7123.1. Documentation requirements may be satisfied by inclusion in the Formulation Agreement the basis of cost and schedule estimates, draft and preliminary versions of project documents and plans, and/or the MCR briefing package.

i. Obtain an approved project FAD.

Reviews

a. Prior to the MCR life cycle review, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

b. Plan, prepare for, and support the MCR life cycle review in accordance with NPR 7123.1, Center practices, and the requirements of this document.

(1) Perform an assessment of the project's readiness to proceed to MCR.

(2) Perform an assessment with respect to the expected maturity states defined in Table F-3 for MCR and KDP A.

c. Identify preliminary plans, if any, for combining life cycle reviews in future life cycle phases

d. Obtain KDP A readiness products.

e. Plan, prepare for, and support the governing PMC review prior to KDP A.

In tightly coupled programs—

a. The projects transition to KDP A in accordance with the Review Plan documented in the Program Plan.

4.4 Projects—Phase A

4.4.1 During Phase A, a project team is formed to update and fully develop the mission concept and begin or assume responsibility for the technology development, engineering prototyping, heritage hardware and software assessments, and other risk-mitigation activities identified in the Project Formulation Agreement. This work, along with interactions with customers and other potential stakeholders, enables updating of the Concept Documentation baselined at KDP A and supports baselining the program requirements on the project. These activities are focused toward System Requirements Review (SRR) and System Definition Review (SDR) (or Mission Definition Review (MDR)). The SRR and SDR (or MDR) process culminates in KDP B. The objectives for SRR and SDR/MDR, and the expected maturity states for SRR, SDR/MDR and KDP B are provided in Table F-3.

4.4.2 During Phase A, the project manager and project team:

a. Support the program manager and the MDAA in developing the baseline program requirement, selection and use of technical standards products, and constraints on the project, including mission objectives, goals, and success criteria.[16] Document driving mission, technical, and programmatic ground rules and assumptions.

b. Support the program manager and the MDAA in ensuring continuing alignment of the project requirements with applicable Agency strategic goals.

c. Plan, prepare for, and support the Acquisition Strategy Meeting (ASM) prior to partnership agreements and obtain the ASM minutes.

d. Support the program manager, the MDAA, and the NASA Headquarters Office of External Relations in initiating interagency and international agreements (including

[16] Program requirements on the project are contained in the Program Plan.

planning and negotiating agreements and recommendations on joint participation in reviews, integration and test, and risk management).

e. Perform the technical activities required in NPR 7123.1 during this phase including:

(1) Define and document project requirements, including allocated and derived requirements. If applicable, identify the payload risk classification, per NPR 8705.4.

(2) Document the updated concept and mission and spacecraft architecture, and define and document the ground and payload architectures.

(3) Update technology development plans, including off-ramps for technologies that are not sufficiently mature, when needed, and corresponding alternate approaches. Implement technology development plans for Phase A identified in the Project Formulation Agreement.

(4) Update and implement engineering development and heritage hardware and software systems development plans for Phase A identified in the Project Formulation Agreement.

(5) Develop an initial list of descope options.

(6) Baseline the Systems Engineering Management Plan.

f. Ensure that a preliminary Project Protection Plan is prepared consistent with existing policies, approved mission requirements, and fiscal realities.

g. Identify potential nonconformance to orbital debris requirements in NASA-STD-8719.14 for planned intentional breakups, reentry of major components that potentially could reach the surface, the planned orbital lifetime, and the use of tethers. Deviations are submitted to the Chief SMA for approval prior to the ASM.

h. Obtain a planetary protection certification for the mission (if required) in accordance with NPD 8020.7, *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft,* and NPR 8020.12, *Planetary Protection Provisions for Robotic Extraterrestrial Missions.*

i. Develop a Nuclear Safety Launch Approval Plan (for missions with nuclear materials) in accordance with NPR 8715.3.

j. Conduct planning that enables continued formulation and implementation of the mission concept, architectures, scenarios/DRMs, and requirements. This includes the following:

(1) Baseline the key ground rules and assumptions that drive development of the mission concept, engineering prototyping plans/status and required funding profiles and schedules for phases A and B, results of technology heritage assessments and key subsystem trade studies, technical requirements, and

programmatic preliminary baseline. Track status of realization, as appropriate, through Phase A.

(2) Update, identify, and assess significant technical and programmatic risks that drive the system requirements, baseline mission concept, operations concept, and technology development. Define and document associated mitigation plans. Identify resources for managing and mitigating risks.

(3) Update, identify, assess and mitigate, if feasible, supply chain risks including potential critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule and report risks to the program in accordance with the approved Acquisition Plan.

(4) Develop acquisition strategy and obtain approval.

(5) Update the initial infrastructure requirements. Complete a preliminary business case analysis for infrastructure for each proposed project real property infrastructure investment consistent with NPD 8820.2, *Design and Construction of Facilities*, and NPR 8820.2, *Facility Project Requirements*, and for the acquisition of new aircraft consistent with NPR 7900.3, *NASA Aircraft Operations Management*.[17]

(6) Update the staffing requirements and plans.

(7) Work with the appropriate NASA Headquarters offices to initiate the development of MOUs/MOAs with external partners, as needed.

(8) Prepare for approval by the program manager a list of long-lead procurements that need to be procured in Phase B.

(9) Develop a preliminary Project Plan.

(10) Develop and document preliminary project baselines and proposed Management Agreement for all work to be performed by the project. This includes a preliminary Integrated Master Schedule (IMS), a risk-informed schedule range estimate, and risk-informed, schedule-adjusted life cycle cost range estimate through completion of Phase D, and the project's technical baseline/mission concept including project requirements, all consistent with the program requirements and constraints levied on the project, key assumptions, workforce estimates, key acquisitions, and significant risks. The preliminary project baselines support the Decision Authority in establishing cost and schedule ranges that can be provided to external stakeholders. The project baseline cost and schedule range estimates include the following:

[17] See the *NASA Business Case Guide for Facilities Projects* at http://www.hq.nasa.gov/office/codej/codejx/Assets/Docs/Case_Guide_4-20-06.pdf

(a) A risk-informed and schedule-adjusted life cycle cost range estimate based on the project's baselines and mission concept. This product will include phased life cycle costs, a preliminary cost confidence level, and a preliminary schedule confidence level. The life cycle cost range estimate is developed using the latest accounting guidance and practices.

(b) Proposed range of annual budgeted costs by Government fiscal year and by the NASA standard space flight WBS. (See Appendix C.)

(c) Proposed range of annual UFE.

(d) The basis for cost and schedule range estimates through completion of Phase D.

(e) A risk-informed, Integrated Master Schedule (IMS) that contains the following key data elements: All task/milestone sequence interdependency assignments, WBS code assignment on all tasks/milestones, current task/milestone progress, and clearly identifiable schedule margin.

(11) For contracts requiring EVM (refer to the NASA FAR Supplement), conduct required IBRs.

(12) For all flight projects, provide a preliminary Cost Analysis Data Requirement (CADRe) (parts A, B, C) consistent with the *NASA Cost Estimating Handbook* (CEH) 60 days prior to the KDP B milestone with a final version 30 days after the KDP event to reflect any decisions from the KDP. This CADRe is based on the Integrated Baseline to be presented at the SDR. (Note: For competed projects, a copy of the winning proposal or concept study report is acceptable.) Prepare and finalize work agreements for Phase B.

k. Develop the project's plans for work to be performed during Implementation life cycle - cycle phases, including generation of life -cycle review plans and project Integrated Master Schedule, details on technical work to be accomplished, key acquisition activities planned, and plans for monitoring performance against plan.

l. Prepare and finalize work agreements for Phase B.

m. In accordance with NPR 2190.1, *NASA Export Control Program*, support the appropriate NASA export control officials to identify and assess export-controlled technical data that potentially will be provided to International Partners and the approval requirements for release of that data, all as a part of developing the project's preliminary Export Control Plan.

n. In coordination with the Office of the Chief Financial Officer (OCFO) and in accordance with NPR 9250.1, *Property, Plant, and Equipment and Operating Materials and Supplies*, complete the Alternative Future Use Questionnaire (Form NF 1739), Section A, to determine the appropriate accounting treatment of capital assets. Once completed, forward the questionnaire to the OCFO, Property Branch. (Note: The questionnaire can be found in NASA's Electronics Forms Database.)

o. Update the Project Formulation Plan for Phase B.

p. Document the results of Phase A activities. Generate the appropriate documentation per NPR 7123.1. Documentation requirements may be satisfied by including in the Formulation Agreement the basis of cost and schedule estimates, draft and preliminary versions of project documents and plans, and/or the SDR (or MDR) briefing package. Unless otherwise noted, documentation requirements may be satisfied by preliminary and baselined documents.

Reviews

a. Prior to the project life cycle reviews shown in Figure 2-4 for this phase, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

b. Plan, prepare for, and support the project SRR and SDR/MDR life-cycle reviews shown in Figure 2-4 for this phase in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the SRR and SDR/MDR objectives and expected maturity states defined in Table F-3. Specifically for this phase:

(1) Perform an assessment of the project's readiness to proceed to SRR and SDR/MDR.

(2) Perform an assessment with respect to the expected maturity states for SRR and SDR/MDR and KDP B.

c. Obtain KDP B readiness products as listed in paragraph 2.3.6.

d. Plan, prepare for, and support the governing PMC review prior to KDP B. (Note: This does not apply to competed missions.)

In tightly coupled programs:

a. Projects transition to KDP B in accordance with the Review Plan documented in the Program Plan.

4.5 Projects—Phase B

4.5.1 During Phase B, the project team conducts technology development, engineering prototyping, heritage hardware and software assessments, and other risk-mitigation activities identified in the Project Formulation Agreement, completes its preliminary design, and establishes schedule and life cycle cost estimates for the project. These activities are focused toward baselining the Project Plan and completing the preliminary design and assuring that the systems engineering activities are complete to ensure the design is feasible for proceeding into Implementation. These activities are focused toward a Preliminary Design Review (PDR) and KDP C where the ABC is established. The objectives for PDR, and expected maturity states for PDR and KDP C are provided in Table F-3.

4.5.2 During Phase B, the project manager and the project team:

a. Obtain an update, if needed, to the baseline program requirements and constraints on the project, including mission objectives/goals, mission success criteria and driving mission, technical and programmatic ground rules and assumptions.

b. Support the program manager and the MDAA in ensuring continuing alignment of the project requirements, design approaches, and conceptual design with applicable Agency strategic goals.

c. Obtain approval of necessary deviations to prescribed requirements with waivers or with updates and modifications to the Formulation Agreement.

d. In coordination with the program manager, the MDAA, and the NASA Headquarters Office of External Relations, support the finalization of external agreements, such as interagency and international agreements (including the planning and negotiation of agreements and recommendations on joint participation in reviews, integration and test, and risk management).

e. Complete the environmental planning process as explained in NPR 8580.1, *NASA National Environmental Policy Act Management.* (Note: For certain projects utilizing nuclear power sources, completion of the environmental planning process can be extended, with the approval of the Decision Authority, into Phase C, but must be completed by the project Critical Design Review (CDR).

f. Develop a preliminary Mishap Preparedness and Contingency Plan in accordance with NPR 8621.1, *Mishap and Close Call Reporting, Investigating, and Recordkeeping*.

g. Coordinate with the Space Operations Mission Directorate (SOMD) if the project involves space transportation services, space communication and navigation capabilities, or launch services, in compliance with NPD 8610.7, *Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions*, and NPD 8610.12, *Space Operations Mission Directorate (SOMD) Space Transportation Services for NASA and NASA-Sponsored Payloads*.

h. Perform the technical activities required in NPR 7123.1. for this phase, including:

(1) Update project-level and system-level requirements and baseline subsystem requirements.

(2) Develop and document the preliminary design.

(3) Complete development of mission-critical or enabling technology, as needed, to the level of a system/subsystem model or prototype demonstration in a relevant environment (ground or space) unless otherwise documented in the Technology Development Plan.

(4) Complete engineering model and prototype developments.

(5) Develop an updated list of descope options.

(6) Develop the integration plan.

(7) Develop preliminary flight operation concepts and plans.

i. Develop a preliminary orbital debris assessment in accordance with NPR 8715.6, *NASA Procedural Requirements for Limiting Orbital Debris*, using the format and requirements contained in NASA-STD-8719.14.

j. Develop preliminary Safety Data Packages in accordance with NPR 8715.7, *Expendable Launch Vehicle Payload Safety Program* and Air Force Space Command Manual 91-710, *Range Safety User Requirements Manual Volume 3 - Launch Vehicles, Payloads, and Ground Support Systems Requirements* (for Expendable Launch Vehicles (ELVs)) and NPR 7120.5 (for human space flight).

k. Develop a baseline planetary protection plan (if required) in accordance with NPD 8020.7 and NPR 8020.12.

l. For launch vehicles, if applicable, develop preliminary documentation that details the Range Safety Risk Management process in accordance with NPR 8715.5, *Range Safety Program*.

m. For human space flight missions, baseline a Human Certification Rating Plan per NPR 8705.2, *Human Rating Requirements for Space Systems.*

n. Conduct planning that enables continued formulation and implementation of the mission. This includes the following:

(1) Confirm or update key ground rules and assumptions that drive project requirements, design approaches, conceptual design, technology development, and programmatic baseline. Provide a status of realization to date. Track status of realization, as appropriate, through Phase B.

(2) Identify, update, and assess significant technical and programmatic risks that drive project requirements, design approaches, conceptual design, and technology development. Define and document associated mitigation plans. Identify resources for managing and mitigating risks.

(3) Update, identify, assess, and mitigate, if feasible, supply chain risks including critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule and report risks to the program in accordance with the approved Acquisition Plan.

(4) Plan and execute long-lead procurements in accordance with the Acquisition Plan. (Note: Long-lead procurements can be initiated in Phase B only when specifically approved by the MDAA.)

(5) Update infrastructure and workforce requirements. Update the business case analysis for infrastructure for each of the project's proposed real property infrastructure investments consistent with NPD 8820.2 and NPR 8820.2, Facility Project Requirements and, for the acquisition of new aircraft, consistent with NPR 7900.3, *Aircraft Operations Management*.[18] (Note: Business case analyses require the approval of the MDAA and the Assistant Administrator for Infrastructure and Administration, or designee.)

(6) Baseline the Project Plan.

(7) Finalize the project baselines and Management Agreement. This includes the technical baseline, project's risk posture, Integrated Master Schedule, and baseline life cycle cost estimate, all consistent with the program requirements and constraints, the key assumptions, workforce estimates, and infrastructure requirements. This should include a review of the entire scope of work with a series of in-depth assessments of selected critical work elements of the WBS prior to and following the project's PDR life cycle review preceding KDP C. The cost and schedule baseline should include:

(a) Risk-informed and cost-loaded or resource-loaded Integrated Master Schedule.

(b) A joint cost and schedule confidence level consistent with the program confidence level approved by the Decision Authority.

(c) The UFE and schedule margins are to be determined by the confidence level provided by the joint cost and schedule calculations. The Integrated Baseline products must provide for adequate technical, schedule, and cost margins and incorporate the impacts of performance to UFE and schedule margin.

(d) Proposed annual estimated costs by Government fiscal year and by the NASA standard WBS (see Appendix C) and an assessment of the consistency of the time-phased Government fiscal year (GFY) life cycle cost estimate with anticipated budget availability. As part of this effort, develop the project's Performance Measurement Baseline (PMB).

(e) When an Independent Cost Estimate (ICE) is required per the convening authority or performed, an explanation of any significant differences with the project's baseline life cycle cost estimate.

(f) Updated basis of estimate for cost and schedule.

(8) For contracts requiring EVM (refer to the NASA FAR Supplement), conduct required IBRs. For projects with EVM requirements, conduct an integrated review

[18] See the *NASA Business Case Guide for Facilities Projects* at http://www.hq.nasa.gov/office/codej/codejx/Assets/Docs/Case_Guide_4-20-06.pdf

of the project baselines as part of the preparations for KDP C to ensure that the project's work is properly linked with its cost, schedule, and risk and that the systems are in place to conduct EVM.

(9) For all flight projects, baseline a CADRe (parts A, B, and C) consistent with the *NASA Cost Estimating Handbook* 60 days prior to KDP C with a final version 30 days after the event to reflect any changes from the KDP. This CADRe is based on the project baselines to be updated at PDR.

(10) Update the project's plans for work to be performed during Phase C and remaining life cycle phases, including updates, if needed, to life cycle review plans, the project Integrated Master Schedule, details on technical work to be accomplished, key acquisition activities planned, and plans for monitoring performance against plan. Incorporate the impact of performance against the plan established at KDP B.

(11) Prepare and finalize Phase C and D work agreements. (Note: Prior to approval to proceed, Phase C and D contracts' work scope and cost/price may be negotiated but not executed. Once the project has been approved and funding is available, the negotiated contracts may be executed, assuming no material changes.)

(12) Baseline cost and schedule management tools and processes.

(13) In coordination with the OCFO, complete the Alternative Future Use Questionnaire (Form NF 1739), Section B, to identify the acquisition components of the project and to determine the appropriate accounting treatment of the capital acquisitions within the project. Once completed, forward the questionnaire to the OCFO, Property Branch. (Note: The questionnaire can be found in NASA's Electronics Forms Database.)

o. Baseline the Project Protection Plan, which describes the processes for complying with the mission's survivability requirements.

p. Document the results of Phase B activities. Generate the appropriate documentation per NPR 7123.1. Documentation requirements may be satisfied by the Project Plan, the basis of cost and schedule estimates, draft and preliminary versions of project documents and plans, and the PDR briefing package. Unless otherwise noted, documentation requirements may be satisfied by preliminary and baselined documents.

q. Document lessons learned in accordance with NPR 7120.6, *Lessons Learned Process,* and NPD 1000.5.

Reviews

a. Prior to the project life cycle reviews shown in Figure 2-4 for this phase, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

b. Plan, prepare for, and support the PDR life cycle review shown in Figure 2-4 for this phase in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the PDR objectives and expected maturity state defined in Table F-3.

   (1) Perform an assessment of the project's readiness to proceed to PDR.

   (2) Perform an assessment with respect to the expected maturity states for PDR and KDP C.

c. Obtain KDP C readiness products as listed in paragraph 2.3.7.

d. Plan, prepare for, and support the governing PMC review prior to KDP C.

In tightly coupled programs:

a. The projects transition to KDP C in accordance with the Review Plan documented in the Program Plan.

4.6 Projects—Phase C

4.6.1 During Phase C, the project completes the design that meets the detailed requirements and begins fabrication of test and flight architecture (e.g., flight article components, assemblies, and subsystems). These activities focus on implementing the project in accordance with the Project Plan, completing the final design, and assuring that the systems engineering activities are performed to determine if the design is mature enough to proceed with full-scale implementation within the constraints of the Management Agreement and the ABC. These activities are focused toward the Critical Design Review (CDR), the Production Readiness Review (PRR) (for three or more copies), and the System Integration Review (SIR). This phase culminates in KDP D. The objectives for CDR, PRR and SIR, and the expected maturity states for CDR, PRR, and SIR and KDP D are provided in Table F-3.

4.6.2 During Phase C, the project manager and the project team implement the baseline Project Plan by doing the following:

a. Obtain an update, if needed, of the baseline program requirements and constraints on the project, including mission objectives/goals and mission success criteria.

b. Update, as needed, project external agreements, partnerships, and acquisition and other plans that are required for successful completion of this and remaining life cycle phases.

c. Update the preliminary Mishap Preparedness and Contingency Plan.

d. Perform the technical activities required in NPR 7123.1 for this phase, including:

   (1) Complete engineering design and development activities (e.g., engineering models, brass boards, bread boards, test beds, and full-up models) and incorporate results into the final design.

(2) Complete and document final flight and ground designs.

(3) Fabricate, purchase, and/or code designs after the appropriate CDR(s).

(4) Begin to implement the defined validation and verification program on flight and/or ground product.

e. Develop the preliminary Operations Handbook. Update the baselined Project Protection Plan, as required.

f. Update the preliminary orbital debris assessment a minimum of 45 days prior to the project CDR in accordance with NPR 8715.6, *NASA Procedural Requirements for Limiting Orbital Debris*, using the format and requirements contained in NASA-STD-8719.14, *Process for Limiting Orbital Debris*.

g. Develop and document Safety Data Packages by the project-level CDR in accordance with NPR 8715.7, *Expendable Launch Vehicle Payload Safety Program*, and Air Force Space Command Manual 91-710, *Range Safety User Requirements Manual Volume 3 - Launch Vehicles, Payloads, and Ground Support Systems Requirements,* (for ELVs), and NPR 7120.5 (for human space flight).

h. For launch vehicles, if applicable, develop baseline documentation that details the Range Safety Risk Management process in accordance with NPR 8715.5, *Range Safety Program*.

i. Develop a preliminary End-of-Mission Plan, per NPR 8715.6.

j. For human spaceflight missions, update the Human Certification Rating Plan per NPR 8705.2, *Human Rating Requirements for Space Systems,* 45 days prior to CDR.

k. Implement the Project Plan, including:

(1) Mature preliminary Project Plan control plans.

(2) Confirm validity and track the realization of key ground rules and assumptions that drive project requirements, designs, and programmatic baseline.

(3) Maintain a record of accepted risks and the associated rationale for their acceptance, actively assess open risks, and develop and implement mitigation plans. Update resources being applied to manage and mitigate risks.

(4) Implement EVM as documented in the Project Plan. For contracts requiring EVM (refer to the NASA FAR Supplement), conduct required IBRs.

(5) Manage technical and programmatic margins and resources to ensure successful completion of this and remaining life cycle phases within budget, schedule, and risk constraints.

(6) Update, identify, assess, and mitigate, if feasible, supply chain risks including critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule and report risks to the program in accordance with the approved Acquisition Plan.

(7) Ensure that appropriate infrastructure and trained and certified staff are available and ready when needed to support the activities of this phase. Update needs as required.

(8) Maintain the project baselines and Management Agreement under configuration management with traceability to the KDP C-approved ABC. As a minimum:

(a) Document basis of estimates for any tasks or system components added since KDP C.

(b) Update the risk-informed, cost-loaded Integrated Master Schedule.

(c) Assess adequacy of anticipated budget availability against phased life cycle cost requirements and commitments, incorporating impact of performance to date.

(d) Provide immediate written notice to the program manager and the MDAA if the latest Phase C through D Estimate at Completion (EAC) of the project exceeds by 15 percent or more the KDP C-approved Management Agreement cost for phases C through D. Provide a written report to the program manager and MDAA explaining the reasons for the change in the cost and a recovery plan within 15 days of the above notification. (Note: Since the Management Agreement cost contains the project UFE, an EAC exceeding the Management Agreement cost presumes that this UFE will be exhausted.)

(e) Provide immediate written notice and a recovery plan to the program manager and the MDAA if a milestone listed for phases C and D on the project life cycle chart (see Figure 2-4) is estimated to be delayed in excess of six months from the date scheduled in the KDP C-approved Management Agreement.

(f) If the trigger points are breached, upon written notice from the program manager, update the Project Plan, per direction received from the program manager.

(9) Update the CADRe (parts A, B, and C) consistent with the *NASA Cost Estimating Handbook* with a final version 30 days after CDR to reflect any changes from the CDR.

(10) Update the project's plans for work to be performed during Phase D and the remaining life cycle phases, including updating, as needed, the life cycle review plans, project Integrated Master Schedule, details on technical work to be

accomplished, key acquisition activities, and plans for monitoring performance against plan. Incorporate the impact of performance against the plan established at KDP C.

(11) Update work agreements and staffing plans for Phase D.

l. Document the results of Phase C activities. Generate the appropriate documentation, per NPR 7123.1.

m. Document lessons learned in accordance with NPR 7120.6 and NPD 1000.5.

Reviews

a. Prior to the project life cycle reviews shown in Figure 2-4 for this phase, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

b. Plan, prepare for, and support the CDR, PRR and SIR life cycle reviews shown in Figure 2-4 for this phase in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the CDR, PRR and SIR objectives and expected maturity states defined in Table F-3.

(1) Perform an assessment of the project's readiness to proceed to CDR, PRR, and SIR.

(2) Perform an assessment with respect to the expected maturity states for CDR, PRR, SIR, and KDP D.

c. Obtain KDP D readiness products as listed in paragraph 2.3.7.

d. Plan, prepare for, and support the governing PMC review prior to KDP D.

In tightly coupled programs:

a. The projects transition to KDP D in accordance with the plan for reviews documented in the Program Plan.

4.7 Projects—Phase D

4.7.1 During Phase D, the project performs system assembly, integration, test, launch, and system checkout activities. These activities focus on preparing for the Operational Readiness Review (ORR), and Flight Readiness Review (FRR) for human space flight programs or the Mission Readiness Review (MRR) for robotic space flight programs, KDP E, launch, and the Post-Launch Assessment Review (PLAR). KDP E marks the decision to conduct launch and early on-orbit operations. The transition to Phase E occurs after on-orbit checkout at the conclusion of the PLAR. (Appendix D provides a detailed description of the flow of the review process in preparation for launch for both human and robotic space flight programs and their

associated projects.) The objectives for ORR, MRR, FRR, and PLAR, and the expected maturity states for ORR, MRR, FRR, PLAR, and KDP E are provided in Table F-3.

4.7.2 During Phase D, the project manager and the project team:

a. Obtain an update, if needed, of the baseline program requirements and constraints on the project, including mission objectives/goals and mission success criteria.

b. Perform the technical activities required in NPR 7123.1 for this phase, including:

(1) Integrate products.

(2) Perform verification on products as they are integrated.

(3) Validate products as they are integrated.

(4) Transition/deliver final products.

(5) Baseline the as-built hardware and software documentation.

(6) Prepare for operations. Update the Operations Concept and the Operations Handbook.

c. Baseline the Program Mishap Preparedness and Contingency Plan to OSMA/Safety and Assurance Requirements Division (SARD) 30 days prior to the Safety and Mission Success Review (SMSR) per NPR 8621.1, *NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping*.

d. Review the baselined Project Protection Plan to manage the relationships and capabilities necessary to integrate institutional security and counter-intelligence disciplines with systems engineering competencies. Identify risks to mission execution due to unmitigated vulnerabilities to operate in and through a degraded, disrupted, or denied space environment. Implement corrective actions to enhance the protection and resilience of critical spacecraft and supporting infrastructure to ensure space-enabled mission essential functions. Baseline the orbital debris assessment in accordance with NPR 8715.6, *NASA Procedural Requirements for Limiting Orbital Debris*, using the format and requirements contained in NASA-STD-8719.14, *Process for Limiting Orbital Debris*.

e. If applicable, provide OSMA/SARD Nuclear Flight Safety Assurance Manager with a listing of all radioactive materials planned for launch with the associated risk assessments 30 days prior to the SMSR in accordance with NPR 8715.3 Chapter 6.

f. If applicable, complete the initial Collision on Launch Analysis, per NPR 8715.5, and present at the FRR.

g. Update Safety Data Packages in accordance with NPR 8715.7, *Expendable Launch Vehicle Payload Safety Program*, and Air Force Space Command Manual 91-710, *Range Safety User Requirements Manual Volume 3 - Launch Vehicles, Payloads, and Ground Support Systems Requirements*, (for ELVs), and NPR 7120.5 (for human space flight).

h. Prepare and document a Decommissioning Plan. Obtain stakeholder and external approvals, as necessary.

i. Implement the Project Plan. Conduct project planning and control, including:

(1) Confirm key ground rules and assumptions that drive project requirements, designs, and programmatic baseline. Track status of performance realization, as appropriate, through this phase.

(2) Ensure that appropriate infrastructure and trained and certified staff are available and ready when needed to support the activities of this phase.

(3) Update, as needed, project external agreements, partnerships, and acquisition and other plans that are required for successful completion of this and remaining life cycle phases.

(4) Maintain a record of accepted risks and the associated rationale for their acceptance; actively assess open risks; and develop and implement mitigation plans. Update resources being applied to manage and mitigate risks.

(5) Manage technical and programmatic margins and resources to ensure successful completion of this and remaining life cycle phases within budget, schedule, and risk constraints.

(6) Update, identify, assess, and mitigate, if feasible, supply chain risks including critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule, and report risks to the program in accordance with the approved Acquisition Plan.

(7) Maintain the project baselines and Management Agreement under configuration management with traceability to the KDP C-approved ABC (or rebaseline when approved). As a minimum:

(a) Document the basis of estimates for any tasks or system components added since KDP D.

(b) Update risk-informed, cost-loaded Integrated Master Schedule.

(c) Assess adequacy of anticipated budget availability against phased life cycle cost requirements and commitments, incorporating the impact of performance to date.

(d) Provide immediate written notice and a recovery plan to the program manager and the MDAA if the latest Phase C through D Estimate at Completion (EAC) of the project exceeds by 15 percent or more the KDP C-approved Management Agreement cost for phases C through D. (Note: Since the Management Agreement cost contains the project UFE, an EAC

exceeding the Management Agreement cost presumes that this UFE will be exhausted.)

(e) Provide immediate written notice and a recovery plan to the program manager and the MDAA if a milestone listed for phases C and D on the project life cycle chart (see Figure 2-4) is estimated to be delayed in excess of six months from the date scheduled in the KDP C-approved Management Agreement.

(f) If the trigger points above are breached and upon written notice from the program manager, update the Project Plan per direction received from the program manager.

(8) Implement EVM as documented in the Project Plan.

(9) For contracts requiring EVM (refer to the NASA FAR Supplement), conduct required IBRs.

(10) Update the CADRe (parts A, B, and C) consistent with the NASA Cost Estimating Handbook with a final version 30 days after FRR to reflect any changes from the FRR.

(11) Update the project's plans for work to be performed during phases E and F, including updating, as needed, the life cycle review plans, project Integrated Master Schedule, details on technical work to be accomplished, key acquisition activities, and plans for monitoring performance against plan. Incorporate impact of performance against the plan that was updated at KDP D.

(12) Prepare and finalize work agreements and staffing plans for Phase E.

j. Obtain approved launch approval documents.

k. Document the results of Phase D activities. Generate the appropriate documentation per NPR 7123.1.

l. Document lessons learned in accordance with NPR 7120.6 and NPD 1000.5.

Reviews

a. Prior to the project life cycle reviews shown in Figure 2-4 for this phase, conduct internal reviews in accordance with NPR 7123.1 (e.g., SAR), Center practices, and the requirements of this document.

b. Plan, prepare for, and support the project life cycle reviews shown in Figure 2-4 for this phase in accordance with NPR 7123.1, Center practices, and the requirements of this document, including ORR, FRR, and PLAR (for human space flight) and ORR, MRR, and PLAR (for robotic), objectives, and expected maturity states defined in Table F-3.

(1) Perform an assessment of the project's readiness to proceed to ORR, FRR or MRR, and PLAR.

(2) Perform an assessment with respect to the expected maturity states for ORR, FRR or MRR, PLAR, and KDP E.

(3) Plan, prepare for, and perform other reviews (e.g., SAR), as necessary.

c. Obtain KDP E readiness products as listed in paragraph 2.3.7.

d. Plan, prepare for, and support the governing PMC review prior to KDP E.

(Detailed charts of the flow of reviews leading to launch can be found in Appendix D.)

In tightly coupled programs:

a. The projects transition to KDP E in accordance with the plan for reviews documented in the Program Plan.

4.8 Projects—Phase E

4.8.1 During Phase E, the project implements the Missions Operations Plan developed in previous phases. This phase begins after the PLAR where the development team transitions mission operations to the project operations team following the initial checkout period after launch. Mission operations may be periodically punctuated with Critical Event Readiness Reviews (CERR). Human space flight missions may conduct PFARs specific to the project needs. The mission operation phase ends with the Decommissioning Review (DR) and KDP F, at which time mission termination is approved. (See Appendix G for a detailed description of the project decommissioning process.) The objectives for CERR, PFAR, and DR, and the expected maturity states for CERR, PFAR, DR, and KDP F are provided in Table F-3.

4.8.2 During Phase E, the project manager and the project team implement the Project Plan by doing the following:

a. Obtain an update, if needed, of the baseline program requirements and constraints on the project, including mission objectives/goals and mission success criteria, if operations performance shortfalls or new mission requirements are identified.

b. Support the program manager and the MDAA in developing options to resolve operations deficiencies or to enhance mission operations performance.

c. Update the Mishap Preparedness and Contingency Plan.

d. Update the baseline orbital debris assessment in accordance with NPR 8715.6, *NASA Procedural Requirements for Limiting Orbital Debris*, using the format and requirements contained in NASA-STD-8719.14, *Process for Limiting Orbital Debris.*

e. Perform the technical activities required in NPR 7123.1. for this phase, including:

(1) Operate product in the intended environment.

(2) Sustain product.

(3) Certify and maintain mission operations readiness, as required.

(4) Capture and archive mission technical results.

(5) Evaluate when ready for end of mission.

f. Implement the Project Plan/Operations Plan. Conduct project planning and control, including:

(1) As directed by the program manager, support the development of Project Plan revisions to continue the mission into extended operations beyond the primary mission phase or beyond any extension previously included in the plan.

(2) Maintain a record of accepted risks and the associated rationale for their acceptance; actively assess open risks, and develop and implement mitigation plans. Update resources being applied to manage and mitigate risks.

(3) Assess adequacy of anticipated budget availability against phased life cycle cost requirements and commitments, incorporating impact of performance to date.

(4) For all flight projects, provide an updated CADRe (parts A, B, and C) consistent with the *NASA Cost Estimating Handbook* within 60 days after the completion of spacecraft post-launch checkout. This CADRe is based on the "as built" launched baseline.

(5) Update the project's plans for work to be performed during Phase F, including updating, as needed, the project Integrated Master Schedule, details on technical work to be accomplished, key acquisition activities and plans for monitoring performance against plan. Incorporate impact of performance against the plan that was updated at KDP E. Prepare or update work agreements and staffing plans for Phase F.

(6) Update, identify, assess, and mitigate, if feasible, supply chain risks including critical or single-source suppliers needed to design, develop, produce, and support required capabilities at planned cost and schedule, and report risks to the program in accordance with the approved Acquisition Plan.

(7) Implement contract closeouts, as appropriate.

(8) Ensure that appropriate infrastructure and trained and certified staff are available and ready when needed to support the activities of this phase.

(9) Update, as needed, project external agreements, partnerships, and acquisition and other plans that are required for successful completion of this and remaining life cycle phases.

g. Document the results of Phase E activities. Generate the appropriate documentation, per NPR 7123.1.

h. Document lessons learned in accordance with NPR 7120.6 and NPD 1000.5.

Reviews

a. Prior to the project life cycle reviews shown in Figure 2-4 for this phase, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

b. Plan, prepare for, and support the project life cycle reviews shown in Figure 2-4 for this phase in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the CERR, PFAR, and DR objectives and expected maturity states defined in Table F-3.

(1) Perform an assessment of the project's readiness to proceed to CERR, PFAR, and DR.

(2) Perform an assessment with respect to the expected maturity states for CERR, PFAR, DR, and KDP F.

c. Obtain KDP F readiness products as listed in paragraph 2.3.7.

d. Plan, prepare for, and support the governing PMC review prior to KDP F.

In tightly coupled programs:

a. The projects transition to KDP F in accordance with the plan for reviews documented in the Program Plan.

4.9 Projects—Phase F

4.9.1 During Phase F, the project implements the Decommissioning Plan developed and approved in Phase E. The project dispositions all spacecraft ground systems, data, and returned samples, including safe and adequate disposal of the spacecraft, other in-space assets, and all project activities are closed out in accordance with the Decommissioning Plan.

4.9.2 During Phase F, the project manager and the project team:

a. Perform the technical activities required in NPR 7123.1. for this phase, including:

(1) Perform spacecraft and other in-space asset disposal and closeout. Monitor decommissioning and disposal risks, actively assess open risks, and develop and implement mitigation plans. Disposition ground systems, test beds, and spares.

(2) Complete archiving of mission/operational and science data.

(3) Complete storage and cataloging of returned samples.

(4) Archive project engineering and technical management data.

(5) Document lessons learned in accordance with NPR 7120.6 and NPD 1000.5.

b. If a Disposal Readiness Review (DRR) life cycle review is conducted during this phase, prior to the DRR, conduct internal reviews in accordance with NPR 7123.1, Center practices, and the requirements of this document.

c. Plan, prepare for, and support the project DRR life cycle review (if needed) in accordance with NPR 7123.1, Center practices, and the requirements of this document, including the DRR objectives and expected maturity state defined in Table F-3.

(1) Perform an assessment of the project's readiness to proceed to the DRR.

(2) Perform an assessment with respect to the DRR expected maturity state.

d. Implement contract closeouts, as appropriate.

e. Provide an update to the CADRe (parts A, B, and C) consistent with the *NASA Cost Estimating Handbook* within 60 days after end of decommissioning and disposal. The purpose is to capture the content and cost of the decommissioning and disposal.

f. Document the results of Phase F activities. Generate the appropriate documentation per NPR 7123.1.

Appendix A. Definitions

Acceptable Risk. Risk that is understood and agreed to by the program or project, governing PMC, Mission Directorate, and other customer(s) to require no further specific mitigating action. (Some mitigating actions might have already occurred.) NASA projects will be assigned a risk classification via NPR 8705.4. Acceptable risk guidance is provided therein.

Acquisition. The process for obtaining the systems, research, services, construction, and supplies that NASA needs to fulfill its missions. Acquisition—which may include procurement (contracting for products and services)—begins with an idea or proposal that aligns with the NASA Strategic Plan and fulfills an identified need and ends with the completion of the program or project or the final disposition of the product or service.

Acquisition Plan. The integrated acquisition strategy that enables a program or project to meet its mission objectives and provides the best value to NASA.

Acquisition Strategy Meeting. A forum where senior Agency management reviews major acquisitions in programs and projects before authorizing budget expenditures. The ASM is held at the Mission Directorate/Mission Support Office level, implementing the decisions that flow out of the ASP meeting and recommending implementation plans for approval. The purpose of the ASM is to review acquisition strategy at a later and more mature stage in the planning cycle than the ASP review. The ASM focuses on considerations such as impacting the Agency workforce, maintaining core capabilities and make-or-buy planning, and supporting Center assignments and potential partners.

Agency Baseline Commitment. Establishes and documents an integrated set of project requirements, cost, schedule, technical content, and an agreed-to JCL that forms the basis for NASA's commitment to the external entities of OMB and Congress. Only one official baseline exists for a NASA program or project and it is the Agency Baseline Commitment.

Agency Program Management Council. The senior management group, chaired by the NASA Associate Administrator or designee that is responsible for reviewing Formulation performance, recommending approval, and overseeing implementation of programs and Category 1 projects according to Agency commitments, priorities, and policies.

Agreement. The statement (oral or written) of an exchange of promises. Parties to a binding agreement can be held accountable for its proper execution, and a change to the agreement requires a mutual modification or amendment to the agreement or a new agreement.

Analysis of Alternatives. A formal analysis method that compares alternative approaches by estimating their ability to satisfy mission requirements through an effectiveness analysis and by estimating their life cycle costs through cost analysis. The results of these two analyses are used together to produce a cost-effectiveness comparison that allows decision makers to assess the relative value or potential programmatic returns of the alternatives. An analysis of alternatives broadly examines multiple elements of program/project alternatives (including technical performance, risk, LCC, and programmatic aspects).

Announcement of Opportunity. An AO is one of two forms of NASA Broad Agency Announcement, which are forms of public/private competition. NASA solicits, accepts, and evaluates proposals submitted by NASA Centers in response to an AO. Regulatory coverage of AOs appears in NASA Federal Acquisition Regulation (FAR) Supplement (NFS) Part 1872. NASA typically uses a one-step or a two-step AO process. In a one-step AO process, projects are competed and selected for Formulation in a single step. In two-step competitions, several projects may be selected in Step 1 and given time to mature their concepts in a funded concept study before the Step 2 down-selection.

Approval. Authorization by a required management official to proceed with a proposed course of action. Approvals are documented.

Approval (for Implementation). The acknowledgment by the Decision Authority that the program or project has met stakeholder expectations and Formulation requirements and is ready to proceed to Implementation. By approving a program or project, the Decision Authority commits the budget resources necessary to continue into Implementation. Approval (for Implementation) is documented.

Architectural Control Document. A configuration-controlled document or series of documents that embodies a cross-Agency mission architecture(s), including the structure, relationships, interfaces, principles, assumptions, and results of the analyses of alternatives that govern the design and implementation of the enabling mission systems.

Baseline (document context). Implies the expectation of a finished product, though updates may be needed, as circumstances warrant. All approvals required by Center policies and procedures have been obtained.

Baseline (general context). An agreed-to set of requirements, cost, schedule, designs, documents, etc., that will have changes controlled through a formal approval and monitoring process.

Baseline Performance Review. A monthly Agency-level independent assessment to inform senior leadership of performance and progress toward the Agency's mission and program or project performance. The monthly meeting encompasses a review of crosscutting mission support issues and all NASA mission areas.

Baseline Science Requirements. The mission performance requirements necessary to achieve the full science objectives of the mission. (Also see **Threshold Science Requirements**.)

Basis of Estimate. The documentation of the ground rules, assumptions, and drivers used in developing the cost or schedule estimates including applicable model inputs, rationale or justification for analogies, and details supporting cost and schedule estimates. The basis of estimate is contained in the material available to the SRB and management as part of the LCR and KDP process.

Budget. A financial plan that provides a formal estimate of future revenues and obligations for a definite period of time for approved programs, projects, and activities. (See NPR 9420.1 and NPR 9470.1 for other related financial management terms and definitions.).

Center Management Council. The council at a Center that performs oversight of programs and projects by evaluating all program and project work executed at that Center.

Change Request. A change to a prescribed requirement in an Agency or Center document that is recommended for all programs and projects for all time.

Compliance Matrix. The Compliance Matrix documents whether and how the program or project complies with the requirements of NPR 7120.5. It provides rationale and approvals for waivers from requirements and is part of retrievable program and project documentation. (For more detail, see NPR 7120.5)

Component Facilities. Complexes that are geographically separated from the NASA Center or institution to which they are assigned, but are still part of the Agency.

Concept Documentation (formerly Mission Concept Report). Documentation that captures and communicates a feasible concept that meets the goals and objectives of the mission, including results of analyses of alternative concepts, the concept of operations, preliminary risks, and potential descopes. It may include images, tabular data, graphs, and other descriptive material.

Concurrence. A documented agreement by a management official that a proposed course of action is acceptable.

Confidence Level. A probabilistic assessment of the level of confidence of achieving a specific goal.

Configuration Management. A management discipline applied over the product's life cycle to provide visibility into and control changes to performance, functional, and physical characteristics.

Conflict of Interest. A conflict of interest involves the abuse—actual, apparent, or potential—of the trust that NASA has in its personnel. An actual conflict of interest is a situation in which financial or other personal considerations have the potential to compromise or bias professional judgment and objectivity. An apparent conflict of interest is one in which a reasonable person would think that the individual's judgment is likely to be compromised. A potential conflict of interest involves a situation that may develop into an actual conflict of interest. A conflict of interest exists whether or not decisions are affected by a personal interest; a conflict of interest implies only the potential for bias, not likelihood.

Continuous Risk Management. A systematic and iterative process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risks associated with implementation of designs, plans, and processes.

Contract. A mutually binding legal relationship obligating the seller to furnish the supplies or services (including construction) and the buyer to pay for them. It includes all types of commitments that obligate the Government to an expenditure of appropriated funds and that, except as otherwise authorized, are in writing. In addition to bilateral instruments, contracts include (but are not limited to) awards and notices of awards; job orders or task letters issued

under basic ordering agreements; letter contracts; orders, such as purchase orders, under which the contract becomes effective by written acceptance or performance; and bilateral contract modifications. Contracts do not include grants and cooperative agreements.

Convening Authority. The management official(s) responsible for convening a program or project review; establishing the Terms of Reference (ToR), including review objectives and success criteria; appointing the SRB chair; and concurring in SRB membership. These officials receive the documented results of the review.

Cost Analysis Data Requirement. A formal document designed to help managers understand the cost and cost risk of space flight projects. The Cost Analysis Data Requirement (CADRe) consists of a Part A "Narrative" and a Part B "Technical Data" in tabular form, both provided by the program/project. Also, the project team produces the project life cycle cost estimate, schedule, and risk identification, which is appended as Part C.

Decision Authority (program and project context). The individual authorized by the Agency to make important decisions on programs and projects under their authority.

Decision Memorandum. The document that summarizes the decisions made at KDPs or, as necessary, in between KDPs. The decision memorandum includes the Agency Baseline Commitment (if applicable), Management Agreement cost and schedule, UFE, and schedule margin managed above the project, as well as life cycle cost and schedule estimates, as required.

Decommissioning. The process of ending an operating mission and the attendant project as a result of a planned end of the mission or project termination. Decommissioning includes final delivery of any remaining project deliverables, disposal of the spacecraft and all of its various supporting systems, closeout of contracts and financial obligations, and archiving of project/mission operational and scientific data and artifacts. Decommissioning does not mean that scientific data analysis ceases, only that the project will no longer provide the resources for continued research and analysis.

Derived Requirements. Requirements arising from constraints, consideration of issues implied, but not explicitly stated, in the high-level direction provided by NASA Headquarters and Center institutional requirements, factors introduced by the selected architecture, and the design. These requirements are finalized through requirements analysis as part of the overall systems engineering process and become part of the program/project requirements baseline. They are established by and are the responsibility of the Programmatic Authority.

Design Documentation. A document or series of documents that captures and communicates to others the specific technical aspects of a design. It may include images, tabular data, graphs, and other descriptive material. Design documentation is different from the CADRe, though parts of design documentation may be repeated in the latter.

Development Costs. The total of all costs from the period beginning with the approval to proceed to Implementation at the beginning of Phase C through operational readiness at the end of Phase D.

Deviation. A documented authorization releasing a program or project from meeting a requirement before the requirement is put under configuration control at the level the requirement will be implemented.

Director, Office of Evaluation. Supports the Administrator, Deputy Administrator, Associate Administrator, and chief of staff to provide objective, transparent, and multidisciplinary assessment and evaluation of all aspects of NASA programs, projects, and institutions. The Office of Evaluation serves as an independent assessment organization, providing objective reviews to the Mission Directorates and APMC of newly proposed and ongoing programs, projects, and institutions for cost-effectiveness, quality, and performance in achieving strategic Agency objectives.

Disposal. The process of getting rid of a project's assets, including the spacecraft and ground systems. Disposal includes the reorbiting, deorbiting, and/or passivation (i.e., the process of removing stored energy from a space structure at the end of mission that could result in an explosion or deflagration of the space structure) of a spacecraft.

Dissenting Opinion. A substantive disagreement with a decision or action that is based on a sound rationale (not solely on unyielding opposition) that an individual judges is of sufficient importance that it warrants a timely review and decision by higher level management, and the individual specifically requests that the dissent be recorded and resolved by the Dissenting Opinion process.

Earned Value Management. A tool for measuring and assessing project performance through the integration of technical scope with schedule and cost objectives during the execution of the project. EVM provides quantification of technical progress, enabling management to gain insight into project status and project completion costs and schedules. Two essential characteristics of successful EVM are EVM system data integrity and carefully targeted monthly EVM data analyses (e.g., identification of risky WBS elements.

Earned Value Management System. An integrated management system and its related subsystems that allow for planning all work scope to completion; assignment of authority and responsibility at the work performance level; integration of the cost, schedule, and technical aspects of the work into a detailed baseline plan; objective measurement of progress (earned value) at the work performance level; accumulation and assignment of actual costs; analysis of variances from plans; summarization and reporting of performance data to higher levels of management for action; forecast of achievement of milestones and completion of events; forecast of final costs; and disciplined baseline maintenance and incorporation of baseline revisions in a timely manner.

Engineering Requirements. Requirements designed to achieve programmatic requirements and relating to the application of engineering principles, applied science, or industrial techniques.

Environmental Impact. The direct, indirect, or cumulative beneficial or adverse effect of an action on the environment.

Environmental Management. The activity of ensuring that program and project actions and decisions that may potentially affect or damage the environment are assessed during the Formulation Phase and reevaluated throughout Implementation. This activity isperformed according to all NASA policy and Federal, State, and local environmental laws and regulations.

Evaluation. The continual self- and independent assessment of the performance of a program or project and incorporation of the evaluation findings to ensure adequacy of planning and execution according to plans.

Final (document context). Implies the expectation of a finished product. All approvals required by Center policies and procedures have been obtained.

Formulation. The identification of how the program or project supports the Agency's strategic goals; the assessment of feasibility, technology and concepts; risk assessment; team building; development of operations concepts, and acquisition strategies; establishment of high-level requirements and success criteria; the preparation of plans, budgets, and schedules essential to the success of a program or project; and the establishment of control systems to ensure performance to those plans and alignment with current Agency strategies.

Formulation Agreement. The Formulation Agreement is prepared by the project to establish the technical and acquisition work that needs to be conducted during Formulation and defines the schedule and funding requirements during Phase A and Phase B for that work.

Formulation Authorization Document. The document issued by the MDAA to authorize the formulation of a program whose goals will fulfill part of the Agency's Strategic Plan and Mission Directorate strategies. In addition, a FAD or equivalent is used to authorize the formulation of a project.

Funding (budget authority). The authority provided by law to incur financial obligations that will result in expenditures. There are four basic forms of budget authority, but only two are applicable to NASA: Appropriations and spending authority from offsetting collections (reimbursables and working capital funds). Budget authority is provided or delegated to programs and projects through the Agency's funds distribution process.

Health and Medical Requirements. Requirements defined by the Office of the Chief Health and Medical Officer.

Highly Specialized Information Technology. Highly specialized Information Technology (IT) is a part of, internal to, or embedded in a mission platform. The platform's function (e.g., avionics, guidance, navigation, flight controls, simulation, radar, etc.) is enabled by IT but not driven by IT itself (e.g., computer hardware and software to automate internal functions of a spacecraft or spacecraft support system, such as spacecraft control and status, sensor signal and data processing, and operational tasking). . Representative examples of highly specialized IT include: Avionics software, real-time control systems, onboard processors, the Deep Space Network, spacecraft instrumentation software, wind tunnel control system, human physiology monitoring systems, ground support environment, experiment simulators, Mission Control Centers, and launch cameras. (For the complete definition, see NPR 7120.7, *NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements*.)

Implementation. The execution of approved plans for the development and operation of the program or project, and the use of control systems to ensure performance to approved plans and continued alignment with the Agency's goals.

Independent Assessment(s) (includes reviews, evaluations, audits, analysis oversight, investigations). Assessments are independent to the extent the involved personnel apply their expertise impartially and without any conflict of interest or inappropriate interference or influence, particularly from the organization(s) being assessed.

Industrial Base. The capabilities residing in either the commercial or government sector required to design, develop, manufacture, launch, and service the program or project. This encompasses related manufacturing facilities, supply chain operations and management, a skilled workforce, launch infrastructure, research and development, and support services.

Information Technology. Any equipment, or interconnected system(s) or subsystem(s) of equipment that is used in the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the Agency.

Infrastructure Requirements. The facilities and environmental, aircraft, personal property, equipment, and information technology resources that are needed to support programs and projects. Utilization of the capability afforded by the infrastructure includes consideration of the maintenance and other liabilities it presents.

Institutional Authority. Institutional Authority encompasses all those organizations and authorities not in the Programmatic Authority. This includes Engineering, Safety and Mission Assurance, and Health and Medical organizations; Mission Support organizations; and Center Directors.

Institutional Requirements. Requirements that focus on how NASA does business that are independent of the particular program or project. There are five types: Engineering, program/project management, safety and mission assurance, health and medical, and Mission Support Office functional requirements.

Integrated Baseline Review. A risk-based review conducted by Program/Project Management to ensure a mutual understanding between the customer and supplier of the risks inherent in the supplier's PMB and to ensure that the PMB is realistic for accomplishing all of the authorized work within the authorized schedule and budget.

Integrated Center Management Council. The forum used by projects and programs that are being implemented by more than one Center and includes representatives from all participating Centers. The ICMC will be chaired by the director of the Center (or representative) responsible for program or project management.

Integrated Logistics Support. The management, engineering activities, analysis, and information management associated with design requirements definition, material procurement and distribution, maintenance, supply replacement, transportation, and disposal that are identified by space flight and ground systems supportability objectives.

Integrated Master Schedule. A logic network-based schedule that reflects the total project scope of work, traceable to the WBS, as discrete and measurable tasks/milestones and supporting elements that are time-phased through the use of valid durations based on available or projected resources and well-defined interdependencies.

Integration Plan. The integration and verification strategies for a project interface with the system design and decomposition into the lower level elements. The integration plan is structured to bring the elements together to assemble each subsystem and to bring all of the subsystems together to assemble the system/product. The primary purposes of the integration plan are: (1) To describe this coordinated integration effort that supports the implementation strategy, (2) to describe for the participants what needs to be done in each integration step, and (3) to identify the required resources and when and where they will be needed.

Interface Control Document. An agreement between two or more parties on how interrelated systems will interface with each other. It documents interfaces between such things as electrical connectors (which type, how many pins, which signals will be on each pin, etc.), fluid connectors (type of connector, type of fluid being passed, flow rates of the fluid, etc.), mechanical (types of fasteners, bolt patterns, etc.), and any other interfaces that might be involved.

Joint Cost and Schedule Confidence Level. (1) The probability that cost will be equal to or less than the targeted cost AND schedule will be equal to or less than the targeted schedule date. (2) A process and product that helps inform management of the likelihood of a project's programmatic success. (3) A process that combines a project's cost, schedule, and risk into a complete picture. JCL is not a specific methodology (e.g., resource-loaded schedule) or a product from a specific tool. The JCL calculation includes consideration of the risk associated with all elements, regardless of whether they are funded from appropriations or managed outside of the project. JCL calculations include the period from KDP C through the hand over to operations, i.e., end of the on-orbit checkout..

Key Decision Point. The event at which the Decision Authority determines the readiness of a program/project to progress to the next phase of the life cycle (or to the next KDP).

Life Cycle Cost. The total of the direct, indirect, recurring, nonrecurring, and other related expenses both incurred and estimated to be incurred in the design, development, verification, production, deployment, prime mission operation, maintenance, support, and disposal of a project including closeout, but not extended operations. The LCC of a project or system can also be defined as the total cost of ownership over the project or system's planned life cycle from Formulation (excluding Pre-Phase A) through Implementation (excluding extended operations). The LCC includes the cost of the launch vehicle.

Life Cycle Review. A review of a program or project designed to provide a periodic assessment of the technical and programmatic status and health of a program or project at a key point in the life cycle, e.g., Preliminary Design Review (PDR) or Critical Design Review (CDR). Certain life cycle reviews provide the basis for the Decision Authority to approve or disapprove the transition of a program/project at a KDP to the next life cycle phase.

Loosely Coupled Programs. These programs address specific objectives through multiple space flight projects of varied scope. While each individual project has an assigned set of mission objectives, architectural and technological synergies and strategies that benefit the program as a whole are explored during the Formulation process. For instance, Mars orbiters designed for more than one Mars year in orbit are required to carry a communication system to support present and future landers.

Management Agreement. Within the Decision Memorandum, the parameters and authorities over which the program or project manager has management control constitute the program or project Management Agreement. A program or project manager has the authority to manage within the Management Agreement and is accountable for compliance with the terms of the agreement.

Margin. The allowances carried in budget, projected schedules, and technical performance parameters (e.g., weight, power, or memory) to account for uncertainties and risks. Margins are allocated in the Formulation process, based on assessments of risks, and are typically consumed as the program/project proceeds through the life cycle.

Metric. A measurement taken over a period of time that communicates vital information about the status or performance of a system, process, or activity.

Mission. A major activity required to accomplish an Agency goal or to effectively pursue a scientific, technological, or engineering opportunity directly related to an Agency goal. Mission needs are independent of any particular system or technological solution.

Mission Directorate Program Management Council. The forum that evaluates all programs and projects executed within that Mission Directorate and provides input to the MDAA. For programs and Category 1 projects, the MDAA carries forward the MD PMC findings and recommendations to the APMC.

Mission Support Office Requirements. Requirements defined by Mission Support Offices (e.g., procurement and medical).

Non-Applicable Requirement. Any requirement not relevant; not capable of being applied.

Operations Concept (formerly Mission Operations Concept). A description of how the flight system and the ground system are used together to ensure that the concept of operation is reasonable. This might include how mission data of interest, such as engineering or scientific data, are captured, returned to Earth, processed, made available to users, and archived for future reference. The Operations Concept should describe how the flight system and ground system work together across mission phases for launch, cruise, critical activities, science observations, and end of mission to achieve the mission.

Orbital Debris. Any object placed in space by humans that remains in orbit and no longer serves any useful function. Objects range from spacecraft to spent launch vehicle stages to components and also include materials, trash, refuse, fragments, and other objects that are overtly or inadvertently cast off or generated.

Performance Measurement Baseline. The time-phased cost plan for accomplishing all authorized work scope in a project's life cycle, which includes both NASA internal costs and supplier costs. The project's performance against the PMB is measured using earned value management (EVM), if required, or other performance measurement techniques if EVM is not required. The PMB does not include UFE.

Preliminary (document context). Implies that the product has received initial review in accordance with Center best practices. The content is considered correct, though some TBDs may remain. All approvals required by Center policies and procedures have been obtained. Major changes are expected.

Prescribed Requirement. A requirement levied on a lower organizational level by a higher organizational level.

Primary Risks. Those undesirable events having both high probability and high impact/severity.

Principal Investigator. A person who conceives an investigation and is responsible for carrying it out and reporting its results. In some cases, Principal Investigators (PIs) from industry and academia act as project managers for smaller development efforts with NASA personnel providing oversight.

Procurement Strategy Meeting. A forum where management reviews and approves the approach for the Agency's major and other selected procurements. Chaired by the assistant administrator for Procurement (or designee), the Procurement Strategy Meeting (PSM) addresses and documents information, activities, and decisions required by the Federal Acquisition Regulation (FAR) and NASA Federal Acquisition Regulation Supplement (NFS) and incorporates NASA strategic guidance and decisions from the ASM strategic acquisition meeting to ensure the alignment of the individual procurement action with NASA's portfolio and mission.

Program. A strategic investment by a Mission Directorate or Mission Support Office that has a defined architecture and/or technical approach, requirements, funding level, and management structure that initiates and directs one or more projects. A program defines a strategic direction that the Agency has identified as critical. (See Section 2.1.2.)

Program Commitment Agreement. The contract between the Associate Administrator and the responsible MDAA that authorizes transition from Formulation to Implementation of a program.
Program/Project Management Requirements. Requirements that focus on how NASA and Centers perform program and project management activities.

Program Plan. The document that establishes the program's baseline for Implementation, signed by the MDAA, Center Director(s), and program manager.

Program/Project Team. All participants in program (project) Formulation and Implementation. This includes all direct reports and others that support meeting program (project) responsibilities.

Programmatic Authority. Programmatic Authority includes the Mission Directorates and their respective program and project managers. Individuals in these organizations are the official

voices for their respective areas. Programmatic Authority sets, oversees, and ensures conformance to applicable programmatic requirements.

Programmatic Requirements. Requirements set by the Mission Directorate, program, project, and PI, if applicable. These include strategic, scientific, and exploration requirements; system performance requirements; safety requirements; and schedule, cost, and similar nontechnical constraints.

Project. A specific investment having defined goals, objectives, requirements, life cycle cost, a beginning, and an end. A project yields new or revised products or services that directly address NASA's strategic needs. They may be performed wholly in house; by Government, industry, or academic partnerships; or through contracts with private industry. (See Section 2.1.2.)

Project Plan. The document that establishes the project's baseline for Implementation, signed by the responsible program manager, Center Director, project manager, and the MDAA, if required.
Rebaselining. The process that results in a change to a project's Agency Baseline Commitment.

Reimbursable Program/Project. A project (including work, commodities, or services) for customers other than NASA for which reimbursable agreements have been signed by both the customer and NASA. The customer provides funding for the work performed on their behalf.

Replanning. The process by which a program or project updates or modifies its plans.

Request for Action/Review Item Discrepancy. The most common names for the comment forms that reviewers submit during life cycle reviews that capture their comments, concerns, and/or issues about the product of documentation. Often RIDs are used in a more formal way, requiring boards to disposition them and having to get agreements with the submitter, project, and board members for their disposition and closeout. RFAs are often treated more informally, almost as suggestions that may or may not be reacted to.

Residual Risk. The remaining risk that exists after all mitigation actions have been implemented or exhausted in accordance with the risk management process. (See NPD 8700.1.)

Risk. The combination of the probability that a program or project will experience an undesired event and the consequences, impact, or severity of the undesired event were it to occur. The undesired event may come from technical or programmatic sources (e.g., a cost overrun, schedule slippage, safety mishap, health problem, malicious activities, environmental impact, failure to achieve a needed scientific or technological objective, or success criterion). Both the probability and consequences may have associated uncertainties.

Risk Assessment. An evaluation of a risk item that determines: (1) what can go wrong, (2) how likely is it to occur, (3) what the consequences are, and (4) what the uncertainties are that are associated with the likelihood and consequences.

Risk Management. Risk management includes risk-informed decision making (RIDM) and continuous risk management (CRM) in an integrated framework. RIDM informs systems engineering decisions through better use of risk and uncertainty information in selecting alternatives and establishing baseline requirements. CRM manages risks over the course of the

development and the Implementation Phase of the life cycle to ensure that safety, technical, cost, and schedule requirements are met. This is done to foster proactive risk management, to better inform decision making through better use of risk information, and then to more effectively manage Implementation risks by focusing the CRM process on the baseline performance requirements emerging from the RIDM process. (See NPR 8000.4, *Agency Risk Management Procedural Requirements*.) These processes are applied at a level of rigor commensurate with the complexity, cost, and criticality of the program.

Risk-Informed Decision Making. A risk-informed decision-making process uses a diverse set of performance measures (some of which are model-based risk metrics) along with other considerations within a deliberative process to inform decision making.

Safety. Freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Safety and Mission Assurance Requirements. Requirements defined by the SMA organization related to safety and mission assurance.

Security. Protection of people, property, and information assets owned by NASA that covers physical assets, personnel, IT, communications, and operations.

Signature. A distinctive mark, characteristic, or thing that indicates identity; one's name as written by oneself.

Single-Project Programs. These programs tend to have long development and/or operational lifetimes, represent a large investment of Agency resources in one program or project, and have contributions to that program/project from multiple organizations or agencies.**Stakeholder.** An individual or organizational customer outside a specific program or project having an interest (or stake) in the outcome or deliverable of a program or project.

Standards. Formal documents that establish a norm, requirement, or basis for comparison, a reference point to measure or evaluate against. A technical standard, for example, establishes uniform engineering or technical criteria, methods, processes, and practices.

Standing Review Board. The board responsible for conducting independent reviews (life cycle and special) of a program or project and providing objective, expert judgments to the convening authorities. The reviews are conducted in accordance with approved Terms of Reference (ToR) and life cycle requirements, per NPR 7120.5 and NPR 7123.1. (See *Standing Review Board (SRB) Handbook* for additional details.)

Success Criteria. That portion of the top-level requirements that defines what is to be achieved to successfully satisfy NASA Strategic Plan objectives addressed by the program or project.

Suppliers. Each project office is a customer having a unique, multi-tiered hierarchy of suppliers to provide it products and services. A supplier may be a contractor, grantee, another NASA Center, university, International Partner, or other government agency. Each project supplier is also a customer if it has authorized work to a supplier lower in the hierarchy.

Supply Chain. The specific group of suppliers and their interrelationships that is necessary to design, develop, manufacture, launch, and service the program or project. This encompasses all levels within a space system, including providers of raw materials, components, subsystems, systems, systems integrators, and services.

System. The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.

Systems Engineering. A disciplined approach for the definition, implementation, integration, and operation of a system (product or service). The emphasis is on achieving stakeholder functional, physical, and operational performance requirements in the intended use environments over planned life within cost and schedule constraints. Systems engineering includes the engineering processes and technical management processes that consider the interface relationships across all elements of the system, other systems, or as a part of a larger system.

Tailoring. The process used to adjust or seek relief from a prescribed requirement to accommodate the needs of a specific task or activity (e.g., program or project). The tailoring process results in the generation of deviations and waivers depending on the timing of the request.

Technical Authority. Part of NASA's system of checks and balances that provides independent oversight of programs and projects in support of safety and mission success through the selection of individuals at delegated levels of authority. These individuals are the Technical Authorities. Technical Authority delegations are formal and traceable to the Administrator. Individuals with Technical Authority are funded independently of a program or project.

Technical Authority Requirements. Requirements invoked by OCE, OSMA, and OCHMO documents (e.g., NPRs or technical standards cited as program or project requirements) or contained in Center institutional documents. These requirements are the responsibility of the office or organization that established the requirement, unless delegated elsewhere.

Technical Standards. NASA, voluntary consensus, and other Government documents that contain common and repeated use of rules, conditions, guidelines, or characteristics for products or related processes, production methods, and related management systems practices. (See NPR 7120.10, *Technical Standards for NASA Programs and Projects*.)

Technology Readiness Level. Provides a scale against which to measure the maturity of a technology. TRLs range from 1, Basic Technology Research, to 9, Systems Test, Launch, and Operations. Typically, a TRL of 6 (i.e., technology demonstrated in a relevant environment) is required for a technology to be integrated into a flight system. (See *Systems Engineering Handbook* NASA/SP-2007-6105 Rev. 1, p. 296, for more information on TRL levels and technology assessment.)

Termination Review. A review initiated by the Decision Authority for the purpose of securing a recommendation as to whether to continue or terminate a program or project. Failing to stay within the parameters or levels specified in controlling documents will result in consideration of a termination review.

Terms of Reference. A document specifying the nature, scope, schedule, and ground rules for an independent review or independent assessment. (See *SRB Handbook.*)

Threshold Science Requirements. The mission performance requirements necessary to achieve the minimum science acceptable for the investment. In some AOs used for competed missions, threshold science requirements may be called the "science floor" for the mission. (Also see **Baseline Science Requirements**.)

Tightly Coupled Programs. Programs with multiple projects that execute portions of a mission(s). No single project is capable of implementing a complete mission. Typically, multiple NASA Centers contribute to the program. Individual projects may be managed at different Centers. The program also may include other agency or International Partner contributions.**Unallocated Future Expenses.** The portion of estimated cost required to meet a specified confidence level that cannot yet be allocated to the specific project WBS subelements because the estimate includes probabilistic risks and specific needs that are not known until these risks are realized.

Uncoupled Programs. Programs implemented under a broad theme and/or a common program implementation concept, such as providing frequent flight opportunities for cost-capped projects selected through Announcements of Opportunity (AO) or NASA Research Announcements. Each such project is independent of the other projects within the program.

Validation. The process of showing proof that the product accomplishes the intended purpose, based on stakeholder expectations. May be determined by a combination of test, analysis, demonstration, and inspection.

Verification. Proof of compliance with design solution specifications and descriptive documents. May be determined by a combination of test, analysis, demonstration, and inspection.

Waiver. A documented authorization releasing a program or project from meeting a requirement after the requirement is put under configuration control at the level the requirement will be implemented.

Work Breakdown Structure. A product-oriented hierarchical division of the hardware, software, services, and data required to produce the program's or project's end product(s), structured according to the way the work will be performed, and reflecting the way in which program or project costs and schedule, technical, and risk data are to be accumulated, summarized, and reported. (See Appendix C.)

Appendix B. Acronyms

AA	Associate Administrator
ABC	Agency Baseline Commitment
ACD	Architectural Control Document
AI&T	Assembly, Integration, and Test
APMC	Agency Program Management Council
AO	Announcement of Opportunity
ASM	Acquisition Strategy Meeting
BOE	Basis of Estimate
BPR	Baseline Performance Review
BTC	Balance to Completion
CADRe	Cost Analysis Data Requirement
CAIB	Columbia Accident Investigation Board
CDR	Critical Design Review
CE	Chief Engineer
CERR	Critical Events Readiness Review
CFO	Chief Financial OfficerCHMO Chief Health and Medical Officer
CM	Configuration Management
CMC	Center Management Council
CoF	Construction of Facilities
COI	Institutional Conflict of Interest
CPR	Center Procedural Requirements (also Contract Performance Report)
CRM	Continuous Risk Management
DOD	Department of Defense
DPMC	Directorate PMC
DR	Decommissioning Review
DRM	Design Reference Mission
DRR	Disposal Readiness Review
EAC	Estimate at Completion
ELV	Expendable Launch Vehicle
EOMP	End of Mission Plan
EPO	Education and Public Outreach
ETA	Engineering Technical Authority
EVM	Earned Value Management
FAD	Formulation Authorization Document
FAR	Federal Acquisition Regulation
FOC	Full Operational Capability
FRR	Flight Readiness Review
FTE	Full-Time EmployeeGDS Ground Data System
GFY	Government Fiscal Year
GOTS	Government Off The Shelf
GSE	Ground Support Equipment

IBPD	Integrated Budget and Performance Document
IBR	Integrated Baseline Review
IC	Intelligence Community
ICD	Interface Control Document
ICE	Independent Cost Estimate
ICMC	Integrated Center Management Council
ILS	Integrated Logistics Support
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IPAO	Independent Program Assessment Office
IPCE	Independent Program and Cost Evaluation
IT	Information Technology
JCL	Joint Cost and Schedule Confidence Level
JPL	Jet Propulsion Laboratory
KDP	Key Decision Point
KPP	Key Performance Parameter
LCC	Life Cycle Cost
LCR	Life Cycle Review
LDE	Lead Discipline Engineer
LRD	Launch Readiness Date
LRR	Launch Readiness Review
MCP	Mishap Contingency Plan
MCR	Mission Concept Review
MD	Mission Directorate
MDAA	Mission Directorate Associate Administrator
MdM	Meta-Data Manager
MD PMC	Mission Directorate Program Management Council
MDR	Mission Definition Review
MOA	Memorandum of Agreement
MOS	Mission Operations System
MOU	Memorandum of Understanding
MRB	Mission Readiness Briefing
MRR	Mission Readiness Review
MSD	Mission Support Directorate
MSO	Mission Support Office
MSOD	Mission Support Office Director
NEN	NASA Engineering Network
NEPA	National Environmental Policy Act
NESC	NASA Engineering and Safety Center
NFS	NASA Federal Acquisition Regulation (FAR) Supplement
NID	NASA Interim Directive
NOA	New Obligation Authority
NODIS	NASA On-Line Directives Information System

NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
OCE	Office of the Chief Engineer
OCFO	Office of the Chief Financial Officer
OCHMO	Office of the Chief Health and Medical Officer
OCI	Organizational Conflict of Interest
ODAR	Orbital Debris Assessment Report
OER	Office of External Relations
OMB	Office of Management and Budget (Executive Office of the White House)
ORR	Operational Readiness Review
OSMA	Office of Safety and Mission Assurance
PCA	Program Commitment Agreement
PCE	Program (or Project) Chief Engineer
PCI	Personal Conflict of Interest
PDLM	Product Data and Life Cycle Management
PDR	Preliminary Design Review
PFAR	Post-Flight Assessment Review
PI	Principal Investigator
PIR	Program Implementation Review
PLAR	Post-Launch Assessment Review
PLM	Product Life Cycle Management
PMB	Performance Measurement Baseline
PMC	Program Management Council
PPBE	Planning, Programming, Budgeting, and Execution
PRR	Production Readiness Review
PSM	Procurement Strategy Meeting
RFA	Request for Action
RFP	Request for Proposal
RID	Review Item Discrepancy
RIDM	Risk-Informed Decision Making
SAR	System Acceptance Review
SARD	Safety and Assurance Requirements Division (of OSMA)
SDR	System Definition Review
SEMP	Systems Engineering Management Plan
SI	*Système Internationale* (or metric) system of measurement
SIR	System Integration Review
SMA	Safety and Mission Assurance
SMATA	Safety and Mission Assurance Technical Authority
SMC	Strategic Management Council
SMD	Science Mission Directorate
SMSR	Safety and Mission Success Review
SOMD	Space Operations Mission Directorate
SOW	Contract Statements of Work

SRB	Standing Review Board
SRR	System Requirements Review
STEM	Science, Technology, Engineering, and Mathematics
TA	Technical Authority
TBD	To Be Determined
TBR	To Be Resolved
ToR	Terms of Reference
TRL	Technology Readiness Level
UFE	Unallocated Future Expenses
V&V	Verification and Validation
WBS	Work Breakdown Structure
WYE	Work Year Equivalent

Appendix C. Space Flight Project Work Breakdown Structure

C.1 Introduction

C.1.1. The Project Work Breakdown Structure (WBS) is a key element of project management. The purpose of a WBS is to divide the project into manageable pieces of work to facilitate planning and control of cost, schedule, and technical content.

C.2 Assumptions

C.2.1 The WBS standard elements defined in this appendix are only applicable to space flight projects.

C.2.2 The following list of assumptions is provided as background information to assist in the development of the project WBS:

a. The Cost Analysis Data Requirement (CADRe) captures major assembly actuals (one level lower than subsystem (as defined in the *NASA Systems Engineering Handbook* (SP-2007-6105 Rev1) and NPR 7123.1)) at major milestones (e.g., PDR, CDR).

b. There are both political and technical requirement drivers to a WBS.

C.3 Project Business Rules

C.3.1 Purpose: The standardization of WBS elements for space flight projects is being driven by requirements for more effective cost estimating and consistency of project work packages across the Agency. The standard WBS is intended to apply to projects, not programs. There are no program WBS standard requirements due to the variance in structure of the Mission Directorates.

C.3.2 Business Rules:

a. The standard space flight project WBS applies to projects established on or after June 1, 2005. It is not intended to be applied retroactively to existing projects.

b. The standard space flight project WBS applies to the entire life cycle of the project, including disposal and decommissioning.

c. The standard space flight project WBS applies to both crewed and robotic projects.

d. Space flight projects will use the standard Level 1/2 WBS elements. (See below.) Specifically:

(1) The Project Name will be WBS Level 1.

(2) The title of each WBS Level 2 element may be modified to facilitate project-unique titles, but the content of each needs to remain the same. If the linkage of

the project-unique title to the standard title is not intuitive, the project-unique title is cross-referenced to the standard.

(3) If the set of standard WBS Level 2 elements does not comprise an exhaustive set of WBS elements, additional WBS elements may be added horizontally (i.e., at Level 2) as long as their content does not fit into the content of any existing standard WBS elements.

(4) For each standard WBS Level 2 element, the subordinate (children) WBS elements at Level 3 and lower will be determined by the project.

(5) The Level 3 and lower elements can differ from project to project but will include only work that rolls up to the standard WBS Dictionary definition of the Level 2 element

(6) If there is no work to fit into a standard WBS element, then an inactive placeholder element (and an inactive placeholder financial code) will be established.

(7) A single WBS will be used for both technical/business management and reporting.

(8) The management assigned to each WBS element may differ from project to project.

e. Changes to the standard space flight project WBS will be governed by the requirement tailoring approval process in Chapter 3 of this document.

C.4 Space Flight Project WBS Standard Elements

C.4.1 Standard Level 2 WBS elements for space flight projects are shown in Figure C-1. The standard WBS template below assumes a typical spacecraft flight development project with relatively minor ground or mission operations elements. For major launch or mission operations ground development activities which are viewed as projects unto themselves, the WBS may be modified. For example, the spacecraft element may be changed to reflect the ground project major deliverable product (such as a facility). The elements such as payload, launch vehicle/services, ground system(s), and mission operations (system) that are not applicable may be deleted. Centers typically provide direction on Level 3 WBS items for important sub-elements, such as Flight Software beneath Spacecraft.

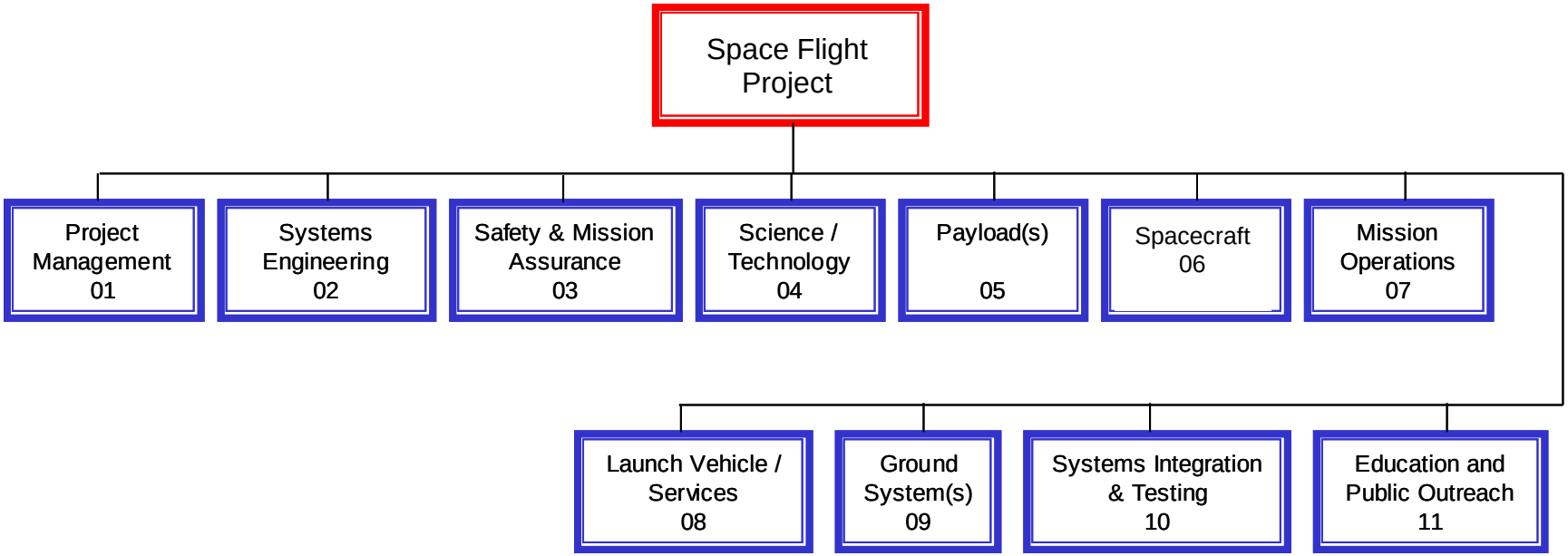


Figure C-1 Standard Level 2 WBS Elements for Space Flight Projects

C.5 Space Flight Project Standard WBS Dictionary

Element 1—Project Management: The business and administrative planning, organizing, directing, coordinating, analyzing, controlling, and approval processes used to accomplish overall project objectives, which are not associated with specific hardware or software elements. This element includes project internal and life cycle reviews and documentation and non-project-owned facilities. It excludes costs associated with technical planning and management and costs associated with delivering specific engineering, hardware, and software products.

Element 2—Systems Engineering: The technical and management efforts of directing and controlling an integrated engineering effort for the project. This element includes the efforts to define the project space flight vehicle(s) and ground system, conducting trade studies, the integrated planning and control of the technical program efforts of design engineering, software engineering, specialty engineering, system architecture development and integrated test planning, system requirements writing, configuration control, technical oversight, control and monitoring of the technical program, and risk management activities. Documentation products include requirements documents, Interface Control Documents (ICDs), Risk Management Plan, and master Verification and Validation (V&V) plan. Excludes any design engineering costs.

Element 3—Safety and Mission Assurance: The technical and management efforts of directing and controlling the safety and mission assurance elements of the project. This element includes design, development, review, and verification of practices and procedures and mission success criteria intended to ensure that the delivered spacecraft, ground systems, mission operations, and payload(s) meet performance requirements and function for their intended lifetimes. This element also includes mishap contingency response and operations. This element excludes mission and product assurance efforts directed at partners and subcontractors other than a review/oversight function, and the direct costs of environmental testing.

Element 4—Science/Technology: This element includes the managing, directing, and controlling of the science investigation aspects, as well as leading, managing, and performing the technology demonstration elements of the Project. The costs incurred to cover the Principal Investigator, project scientist, science team members, and equivalent personnel for technology demonstrations are included. Specific responsibilities include defining the science or demonstration requirements; ensuring the integration of these requirements with the payloads, spacecraft, ground systems, and mission operations; providing the algorithms for data processing and analyses; and performing data analyses and archiving. This element excludes hardware and software for onboard science investigative instruments/payloads.

Element 5—Payload(s): This element includes the equipment provided for special purposes in addition to the normal equipment (i.e., ground support equipment (GSE)) integral to the spacecraft. This includes leading, managing, and implementing the hardware and software payloads that perform the scientific experimental and data-gathering functions placed on board the spacecraft, as well as the technology demonstration for the mission.

Element 6—Spacecraft: The spacecraft that serves as the platform for carrying payload(s), instrument(s), humans, and other mission-oriented equipment in space to the mission destination(s) to achieve the mission objectives. The spacecraft may be a single spacecraft or multiple spacecraft/modules (i.e., cruise stage, orbiter, lander, or rover modules). Each

spacecraft/module of the system includes the following subsystems, as appropriate: Crew, Power, Command & Data Handling, Telecommunications, Mechanical, Thermal, Propulsion, Guidance Navigation and Control, Wiring Harness, and Flight Software. This element also includes all design, development, production, assembly, test efforts, and associated GSE to deliver the completed system for integration with the launch vehicle and payload. This element does not include integration and test with payloads and other project systems.

Element 7—Mission Operations System: The management of the development and implementation of personnel, procedures, documentation, and training required to conduct mission operations. This element includes tracking, commanding, receiving/processing telemetry, analyses of system status, trajectory analysis, orbit determination, maneuver analysis, target body orbit/ephemeris updates, and disposal of remaining end-of-mission resources. The same WBS structure is used for Phase E Mission Operation Systems but with inactive elements defined as "not applicable." (See "Other Policy Documents" section of NODIS for *WBS Handbook*.) However, different accounts must be used for Phase E due to NASA cost reporting requirements. This element does not include integration and test with the other project systems.

Element 8—Launch Vehicle/Services: The management and implementation of activities required to place the spacecraft directly into its operational environment, or on a trajectory towards its intended target. This element includes launch vehicle, launch vehicle integration, launch operations, any other associated launch services (frequently includes an upper-stage propulsion system), and associated GSE. This element does not include the integration and test with the other project systems.

Element 9—Ground System(s): The complex of equipment, hardware, software, networks, and mission-unique facilities required to conduct mission operations of the spacecraft systems and payloads. This complex includes the computers, communications, operating systems, and networking equipment needed to interconnect and host the Mission Operations software. This element includes the design, development, implementation, integration, test, and the associated support equipment of the ground system, including the hardware and software needed for processing, archiving, and distributing telemetry and radiometric data and for commanding the spacecraft. Also includes the use and maintenance of the project test beds and project-owned facilities. This element does not include integration and test with the other project systems and conducting mission operations.

Element 10—Systems Integration and Testing: This element includes the hardware, software, procedures, and project-owned facilities required to perform the integration and testing of the project's systems, payloads, spacecraft, launch vehicle/services, and mission operations.

Element 11—Education and Public Outreach: Provide for the Education and Public Outreach (EPO) responsibilities of NASA's missions, projects, and programs in alignment with the Strategic Plan for Education. This includes management and coordinated activities, formal education, informal education, public outreach, media support, and Web site development.

Appendix D. Flow Charts of Review Process in Preparation for Launch

For human space flight programs, a project's preparation for KDP E includes reviewing operations system readiness at an ORR (during Phase D); reviewing implementing Center readiness at the Center FRR/LRR; reviewing Agency Technical Authority readiness at the SMSR; reviewing project and program readiness at the pre-FRR and program FRR; and bringing the results of the Center FRR/LRR, SMSR, and program FRR to the Agency FRR, where the MDAA or Decision Authority approves the project's transition through the launch event into mission operations. The Agency FRR constitutes the MD PMC/APMC, and the KDP E decision is made at the end of this meeting. Following the Agency FRR, the rollout review and the L-1 review are conducted, culminating in launch. A flow chart for KDP E for human space flight programs is illustrated in Figure D-1.

For robotic programs, a project's preparation for KDP E includes reviewing the operations system readiness at an ORR, the implementing Center and overall mission systems readiness at an MRR, and the Technical Authority readiness at the SMSR and bringing the results of each of these to the mission readiness briefing (MRB) where the MDAA approves the project's transition through the launch event into mission operations. The MRB constitutes the governing PMC for Category 2 and 3 projects and most Category 1 projects[19], and the KDP E decision is made at the end of this meeting. Category 1 projects with nuclear power sources will usually have an APMC, where the KDP E decision will be made at the end of the APMC. After the launch vehicle readiness is reviewed at the FRR, all come to the LRR for the final launch decision. A flow chart for KDP E for robotic space flight programs is illustrated in Figure D-2.

[19] Decision Authority for KDP E is usually delegated to the MDAA by the AA, except for projects with nuclear power sources.

KDP-E Process for Human Spaceflight Programs

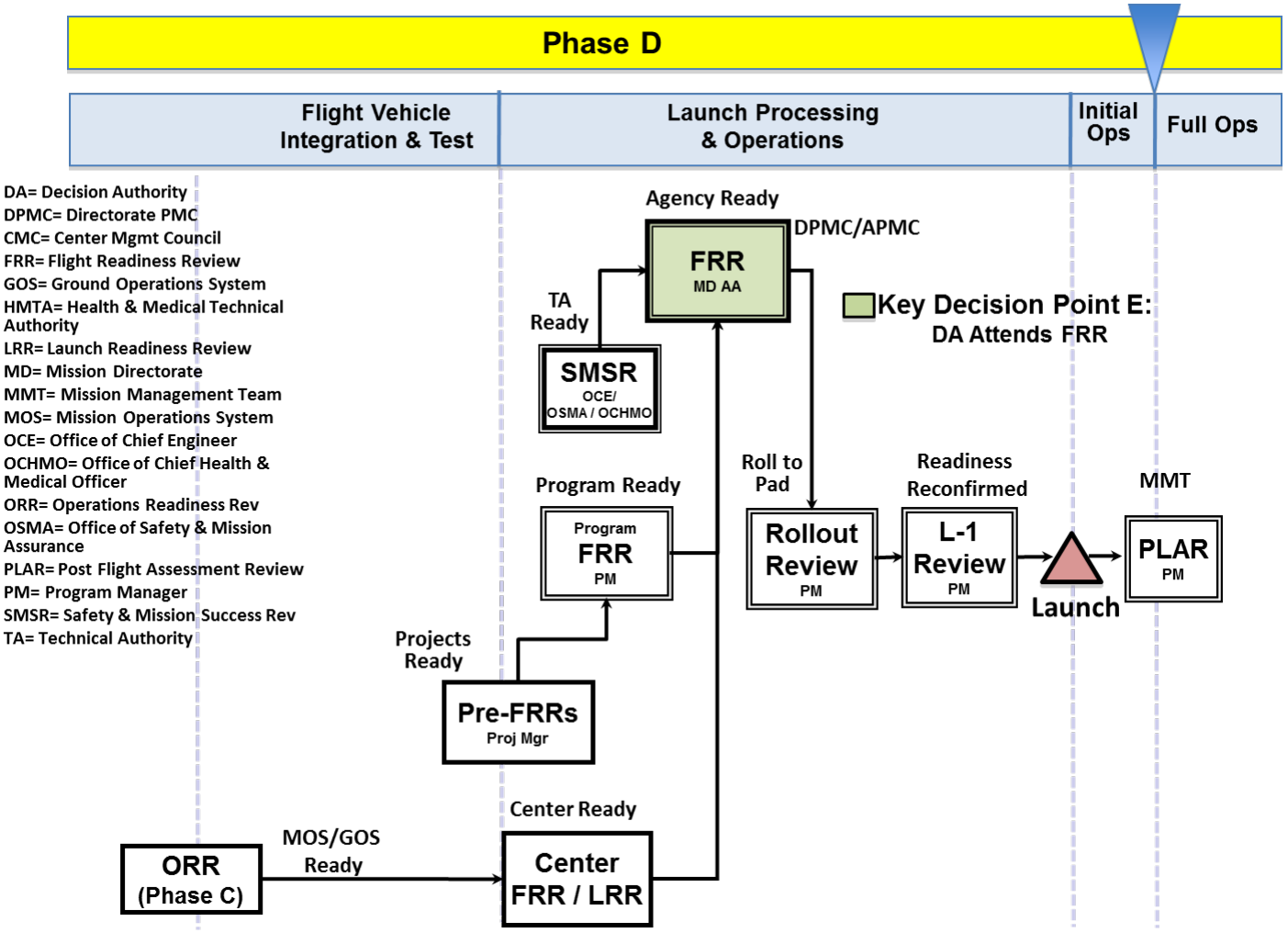


Figure D-1 KDP E Process for Human Space Flight Programs

KDP-E Process for Robotic Spaceflight Programs

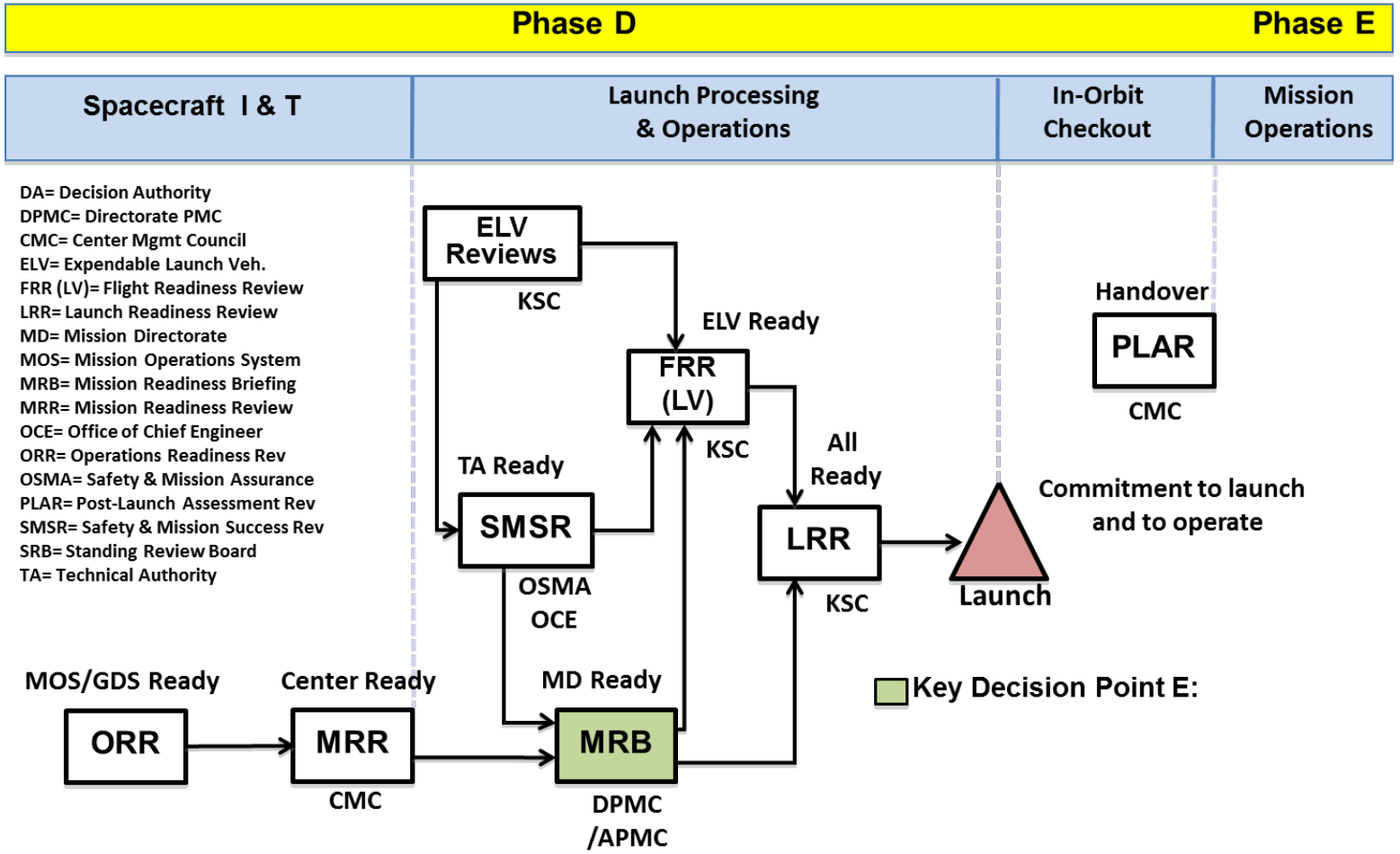


Figure D-2 KDP E Process for Robotic Space Flight Programs

Appendix E. Decision Memorandum Templates

E.1 Program Decision Memorandum

NASA [Agency Program Management Council Program[20]] Decision Memorandum

Summary: The Agency Program Management Council (APMC) met on [Date] and evaluated the [XYZ] Program Key Decision Point [0/I/II/III/IV][21] of the life cycle, as defined in NASA Procedural Requirement 7120.5: *Space Flight Program and Project Management Requirements*. [Briefly describe outcome, select the appropriate phrasing.]

Decision: At KDP 0: Based on this review and the program readiness, the Decision Authority for the [XYZ] Program [approves/disapproves] entry of this program into Formulation consistent with the Formulation Authorization Document (FAD). This decision includes the actions specified below. [Provide or reference any additional direction and the documentation consistent with NPR 7120.5, Section 2.5.] Attach the FAD, along with supporting data for the cost and schedule information, as applicable.

Decision: At KDP [I,II,III,IV]: Based on this review and the program readiness, the Decision Authority for the [XYZ] Program at KDP [I,II,III,IV] [approves/disapproves] entry of this program into Implementation consistent with the Program Commitment Agreement (PCA). This decision includes the actions specified below. [Provide or reference any additional direction and the documentation consistent with NPR 7120.5, Section 2.5.] Attach the PCA, along with supporting data for the cost and schedule information, as applicable.

Amendment: Based on this review and the program readiness, the Decision Authority for the [XYZ] Program [approves/disapproves] amendment to KDP [I, II, III, IV] and continuation of the Program. This decision includes the actions specified below. [Provide any additional direction here and specify whether this direction is to be reflected in an updated PCA and/or Program Plan.] Attach the supporting document, along with supporting data for the cost and schedule information, as applicable.

Actions: Include this section if there are any actions to report.

Action Number: [Specify who has the action and the date or milestone for completion of the actions; include any additional direction on these actions.]

[20] NASA AA approves program transition from KDP to next life cycle phase.

[21] Applicable for all program KPDs.

APMC Concurrence

Program Director	Date	Program Manager	Date
MD Associate Administrator	Date	Center Director (s)	Date
Chief Engineer	Date	Chief Financial Officer	Date
Chief, OSMA	Date	IPAO Associate Administrator	Date

Approval

Associate Administrator	Date

Optional Concurrence[22]

Project/Mission Manager	Date	Program Executive	Date
MD Division/Theme Director	Date	Principal Investigator	Date
Chief Health & Safety Officer	Date		Date

[22] If required by the MD AA except Health & Safety, which is determined by the project.

E.2 Project Decision Memorandum

NASA [Agency/Directorate] Program Management Council
[Project] KDP [A/B/C/D/E] Decision Memorandum

Summary: The [Directorate/Agency] Program Management Council met on [Date] and evaluated the [XYZ] [Project] Key Decision Point [A/B/C/D/E] of the life cycle, as defined in NPR 7120.5, *Space Flight Program and Project Management Requirements*. [Briefly describe outcome.]

Decision: Based on this review and the project readiness, the Decision Authority for the [XYZ] project provides the following decision for KDP [A/B/C/D/E] with the content, schedule, and cost profile specified in the attached summary and specified in tables 1 and 2, below. This decision includes the actions specified below.

[Provide or reference any additional direction and the documentation of the Management Agreement consistent with NPR 7120.5, Section 2.5.] Attach a summary of the project content and acquisition strategy, along with supporting data for the cost and schedule information provided in tables 1 and 2.

Select the version of the table that matches the appropriate KDP, amendment, or rebaseline:

IOC is Initial Operational Capability
FOC is Full Operational Capability
LRD is Launch Readiness Date
BTC is Balance to Completion

Table E-1a: KDP A Preliminary Cost and Schedule Estimate

KDP A

	Management Agreement [1]	**Total** [2]
Cost (Phase A only)		[If there is no UFE, this will be the same as the MA]
KDP B Planned Date		
Schedule—Target [LRD, IOC, or FOC]		[Schedule to be range]
Years/Months of Operations - Target		
Cost - Target	[If applicable]	[LCC Range Estimate]

Table E-1b: Phased Cost Estimate

	Prior costs	**Phasing by year**					**BTC** [4]
		FY n	**FY n+1**	**FY n+2**	**FY n+3**	**FY n+4**	
Management Agreement							
Total							

KDP B

Table E-2a: KDP B Preliminary Cost and Schedule Estimate

	Management Agreement [1]	**Total** [2]
Cost (Phase B only)		[If there is no UFE, this will be the same as the MA]
KDP C Planned Date		
Schedule—Target [LRD, IOC, or FOC]		[Schedule to be a range]
Years/Months of Operations - Target		
Confidence Level (Cost)		
Confidence Level (Schedule)		
Cost - Target	[If applicable]	[LCC Range Estimate]

Table E-2b: Phased Cost Estimate

	KDP A Costs	**Phasing by year**					**BTC** [4]
		FY n	**FY n+1**	**FY n+2**	**FY n+3**	**FY n+4**	
Management Agreement							
Total							

Amend

Table E-3a: Formulation Replan Amendment - Preliminary Cost and Schedule Estimate

	Management Agreement [1]		**Total** [2]	
	From	**To**	**From**	**To**
Cost (Phase A or B)				
KDP Event Planned Date				
Schedule—Target [LRD, IOC, or FOC]				
Years/Months of Operations - Target				
Confidence Level (Cost)				
Confidence Level (Schedule)				
Cost -Target	[If applicable]			

Table E-3b: Amendment Phasing Cost Estimate

	Prior Phase(s)	**Phasing by year**					**BTC** [4]
		FY n	**FY n+1**	**FY n+2**	**FY n+3**	**FY n+4**	
Management Agreement							
Total							

KDP C

Table E-4a: KDP C Cost and Schedule Baseline Commitments

	Management Agreement [1]	Agency Baseline Commitment (ABC) [2,3]
Formulation Costs (Phases A & B) [5]		
Development Costs (Phases C & D) [5]		
Prime Operations and Closeout Costs (Phases E & F) [5]		
TOTAL COSTS		
Schedule [LRD, IOC, or FOC]		
Years/Months of Operations		
Joint Confidence Level (Cost and Schedule)		

Table E-4b: Phasing to Completed Project at KDP C

	KDP A & B Costs	Phasing by year to complete Phase [C]					BTC [4]
		FY n	FY n+1	FY n+2	FY n+3	FY n+4	
Management Agreement							
Total							

Amend

Table E-5a: Replan Amendment at KDP D or During Implementation—Cost and Schedule

	Management Agreement [1]		ABC [2,3]	Growth	Total [2]
	Previous	Current			
Formulation Costs (Phases A & B) [5]					
Development Costs (Phases C & D) [5]					
Prime Operations and Closeout Costs (Phases E & F) [5]					
TOTAL COSTS					
Schedule [LRD, IOC, or FOC]					
Years/Months of Operations					
Joint Confidence Level (Cost and Schedule)		[If updated]			[If updated]

Table E-5b: Phasing to Complete the Project at KDP [C/D/E] Decision

	Prior Phase (s)	Phasing by year to complete Phase [C/D/E]					BTC [4]
		FY n	FY n+1	FY n+2	FY n+3	FY n+4	
Management Agreement							
Total							

ABC Rebaseline

Table E-6a: ABC Rebaseline Amendment for Cost and Schedule

	Management Agreement [1]		Agency Baseline Commitment (ABC) [2,3]	
	From	**To**	**Previous**	**Current**
Formulation Costs (Phases A & B) [5]				
Development Costs (Phases C & D) [5]				
Prime Operations and Closeout Costs (Phases E & F) [5]				
TOTAL COSTS				
Schedule [LRD, IOC, or FOC]				
Years/Months of Operations				
Joint Confidence Level (Cost and Schedule)		[If updated]		[If updated]

Table E-6b: Rebaseline Phasing for New ABC

	Prior Phase (s)	Phasing by year to complete Phase [C/D/E]					BTC [4]
		FY n	FY n+1	FY n+2	FY n+3	FY n+4	
Management Agreement							
Total							

Actions: [Include this section if there are any actions to report.]

Action Number: [Specify who has the action, the date, or milestone for completion of the actions. Include any additional direction on these actions.]

[1] Includes cost and schedule aspects of the Management Agreement including the Unallocated Future Expenses (UFE) and schedule margin managed by the project, the project labor, and the project Construction of Facilities (CoF) cost.

[2]Includes all project UFE and schedule margin, including UFE and margin to be managed above the project. Also includes legacy indirect costs, if applicable.

[3]Completed at KDP C and changed only if project is being rebaselined.

[4]Balance to completion.

[5]These costs do not reflect the budget numbers and do include labor and CoF; refer to the project datasheet for further information.

(Select the Signature Block associated with the Decision Authority. See ____ document for information on what each party is concurring with.)

DPMC

Concurrence

Program Manager	Date	Center Director(s)	Date
Chief Engineer Designee	Date	Chief Financial Officer Designee	Date
IPAO Associate Administrator	Date	OSMA Designee	Date

Approval

MD Associate Administrator	Date
Associate Administrator[23]	Date

Optional Concurrence[24]

Project/Mission Manager	Date	Program Executive	Date
MD Division/Theme Director	Date	Principal Investigator	Date
Health & Safety Designee	Date		

During Formulation, the project manager agrees that the ensuing phase can be completed within the Management Agreement. During Implementation, the project manager agrees that the project life cycle can be completed within the Management Agreement; the program manager and Mission Directorate agree that the project can be completed within the ABC as listed in the right column in the "a" tables above.

[23] The AA approves the KDP C for projects with a life cycle cost greater than $250 million.

[24] If required by the MD AA except Health & Safety, which is determined by the project.

APMC

Concurrence

Program Manager	Date	Project/Mission Manager	Date
MD Associate Administrator	Date	Center Director (s)	Date
Chief Engineer	Date	Chief Financial Officer	Date
Chief, OSMA	Date	IPAO Associate Administrator	Date

Approval

Associate Administrator	Date

Optional Concurrence[25]

MD Division/Theme Director	Date	Program Executive	Date
Chief Health & Safety Officer[2]	Date	Principal Investigator	Date

During Formulation, the project manager agrees that the ensuing phase can be completed within the Management Agreement. During Implementation, the project manager agrees that the project life cycle can be completed within the Management Agreement; the program manager and Mission Directorate agree that the project can be completed within the ABC, as listed in the right column in the "a" tables above.

E.3 Additional Decision Memorandum Attachments

KDP Supporting Content

[25] If required by the MD AA except Health & Safety, which is determined by the project.

Provide an update of the project pages in the Agency's Budget to Congress to the plan approved at the KDP. If this project has not been featured in the Agency's budget previously, provide the content that will be required for the forthcoming budget. (The contract table below is not included in the Agency's budget, but is included in other Agency reporting.)

Project Name

Phase

Project Purpose

Project Parameters

Project Deliverables

Table E-7: Project Deliverables			
Project Element	**Provider**	**Description**	**Change From Last Budget to Congress**

Project Schedule

Table E-8: KDP C Project Schedule Commitment		
Milestone Name	**Last Budget to Congress:**	**KDP Schedule:**
	Month and year	Month and year

Project Management

Table E-9: Project Management Strategy			
Project Element	**Element Oversight**	**Lead Performer**	**Partners**

Acquisition Strategy

Table E-10: Development Contract Awards							
Contract Descrip-tion	**Con-tract #**	**Provider**	**Element(s) Supported**	**Date Awarded**	**Original Value**	**Date Changed**	**Updated Value**

Independent Reviews

Table E-11: Independent Reviews				
Review Type	**Performer**	**Last Review**	**Purpose/Outcome**	**Next Review**

Risk Management

Table E-12: KDP C Risks		
#/Title	**Risk Statement**	**Risk Management Approach and Plan**

Appendix F. Maturity Tables

Table F-1 Expected Maturity State Through the Uncoupled and Loosely Coupled Program Life Cycle

NOTE: LCR entrance and success criteria in Appendix G of NPR 7123.1 and the life cycle phase and KDP requirement in NPR 7120.5 provide specifics for addressing the expected maturity state.

KDP Review	Associated Life Cycle Review	LCR Objectives		Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
				Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
KDP 0[1]	**SRR**	To evaluate whether the program functional and performance requirements are properly formulated and correlated with the Agency and Mission Directorate strategic objectives; to assess the credibility of the program's estimated budget and schedule.		The Program has merit and is within the Agency scope; program requirements reflect Mission Directorate requirements and constraints, and are approved.	Program FAD has been approved and a preliminary Program Plan is appropriately mature; the management framework is in place with key interfaces and partnerships identified; and preliminary acquisition strategy is defined.	Functional and performance requirements have been defined, and the requirements will satisfy the Mission Directorate needs; a feasible set of program implementation options has been identified that broadly addresses the functional and performance requirements.	Credible risk-informed program implementation options exist that fit within desired schedule and available funding profile.	Preliminary staffing and essential infrastructure requirements have been identified and documented; preliminary sources have been identified.	The driving risks associated with each identified program implementation option have been identified; approaches for managing these risks have been proposed and are adequate.	Overall KDP 0: Program addresses critical NASA needs and can likely be achieved as conceived.
KDP I	**SDR**	To evaluate the proposed program requirements/ architecture and allocation of requirements to initial projects; to assess the adequacy of project pre-Formulation efforts; to determine whether the maturity of the program's		Program requirements, program approaches, and initial projects reflect Mission Directorate requirements and constraints, and will fulfill the program needs and success criteria.	Program Plan and PCA are complete and management infrastructure, including interfaces and partnerships, are in place; initial project(s) have been identified and project pre-Formulation is ready to be (or already) started; technology development plans are adequate, and	Driving program and project requirements have been defined, and program architectures, technology developments and operating concepts respond to them; initial project pre-Formulation responds to	Credible cost/schedule estimates are supported by a documented BOE and are consistent with driving assumptions, risks, system requirements, conceptual designs, and available funding and schedule	Availability, competency and stability of staffing, essential infrastructure and additional resources other than budget are adequate for remaining lifecycle phases.	Significant program and project development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	Overall KDP I: Program is in place and stable; addresses critical NASA needs; has adequately completed Formulation activities; has an acceptable plan for Implementation that leads to mission success;

KDP Review	Associated Life Cycle Review	LCR Objectives		Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
				Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
		definition and associated plans are sufficient to begin implementation.			acquisition strategy is approved.	program needs and appears feasible.	profile.			proposed projects are feasible within available resources; and the program's risks are commensurate with the Agency's expectations.
KDP II to KDP n	**PIR**	To evaluate the program's continuing relevance to the Agency's Strategic Plan; to assess performance with respect to expectations; to determine the program's ability to execute the implementation plan with acceptable risk within cost and schedule constraints.		Program's goals, objectives and requirements remain consistent with the Agency strategic goals; requirements are complete and properly flowed down to projects.	Program Plan and PCA are up-to-date and management infrastructure, including interfaces and partnerships, are working efficiently; program/project relationships are good; technology development plans remain adequate; and acquisition strategy is working properly.	Program's technical approach and processes are enabling project mission success; and technology development activities (if any) are enabling improved future mission performance; projects are proceeding as planned.	Credible cost/schedule estimates are supported by a documented BOE and are consistent with driving assumptions, risks, project implementation, and available funding and schedule profile.	Availability, competency and stability of staffing, essential infrastructure and additional resources other than budget are adequate for continuing program acquisitions and operations.	Significant program and project development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	Overall KDP II to KDP n: Program still meets Agency needs and is continuing to meet Agency commitments as planned.

[1] KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.

Table F-2 Comprehensive Expected Maturity State Through the Tightly Coupled Program Life Cycle

NOTE: LCR entrance and success criteria in Appendix G of NPR 7123.1 and the life cycle phase and KDP requirement in NPR 7120.5 provide specifics for addressing the expected maturity state.

KDP Review	Associated Life Cycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
KDP 0[1]	SRR	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.	Overall KDP 0 Expected State: Program addresses critical NASA needs and projects are feasible within available resources.
	SDR	To evaluate the credibility and responsiveness of the proposed program requirements/architecture to the Mission Directorate requirements and constraints, including available resources, and allocation of requirements to projects; to determine whether the maturity of the program's mission/system definition and associated plans are sufficient to begin preliminary design.	Program requirements, program approaches, and initial projects incorporate Mission Directorate requirements and constraints, and will fulfill the program needs and success criteria; and allocation of program's requirements to projects is complete.	Draft Program Plan and PCA are appropriately mature and management infrastructure, including interfaces and partnerships, are in place; project formulation is underway; technology development plans are adequate, and acquisition strategy is approved and initiated.	Driving program and project requirements have been defined, and program architectures, technology developments and operating concepts respond to them; initial project formulation responds to program needs and appears feasible.	Credible cost and schedule range estimates and associated confidence levels are supported by a documented BOE and are consistent with driving assumptions, risks, system requirements, conceptual design, and available funding.	Availability, competency and stability of staffing, essential infrastructure and additional resources other than budget are adequate for remaining lifecycle phases.	Significant mission, development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	
KDP I	PDR	To evaluate the completeness/consistency of the Program's preliminary design, including its projects, in meeting all requirements with appropriate margins, acceptable risk and within cost and	Program requirements and Program/Project preliminary designs satisfy Mission Directorate requirements and constraints, mission needs and success	Program Plan and PCA are complete; external agreements and infrastructure business case are in place; contractual instruments are in place; and execution plans for the remaining phases are appropriate;	Program and project preliminary designs satisfactorily meet requirements and constraints with acceptable risk; projects are properly	The integrated cost/schedule baseline has a sound basis and is consistent with driving assumptions; reflects risks; is fully supported by a documented BOE; fits within the available funding and schedule	Adequate agreements exist for staffing, essential infrastructure and additional resources, as appropriate, for remaining lifecycle	Mission, development and safety risks are addressed in designs and operating concepts; a process and resources exist to effectively manage or	Overall KDP I Expected State: Program preliminary design and programmatic plans enable Agency commitments.

KDP Review	Associated Life Cycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
		schedule constraints; and to determine the Program's readiness to proceed with the detailed design phase of the program.	criteria.	projects have successfully completed their PDRs per the Program Plan.	integrated into the larger system.	profile; and cost/schedule management tools/ processes are in place.	phases.	mitigate them.	
KDP II	**CDR**	To evaluate the integrity of the program integrated design, including its projects and ground systems, to meet mission requirements with appropriate margins and acceptable risk, within cost and schedule constraints; to determine if the integrated design is appropriately mature to continue with the final design and fabrication phase.	Changes in program scope affecting Mission Directorate requirements & constraints have been approved and documented and have been or will be implemented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining life cycle phases; projects have successfully completed their CDRs per the Program Plan.	Detailed Program and project design satisfactorily meets requirements and constraints with acceptable risk.	Driving ground rules and assumptions are realized; adequate technical and programmatic margins and resources exist to complete the remaining life cycle phases of the program within budget, schedule and risk constraints.	Infrastructure and staffing for final design and fabrication are available/ready; adequate agreements exist for remaining life cycle phases.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	Overall KDP II Expected Maturity: Program ready for AI&T with acceptable risk within Agency commitments.
	SIR	To evaluate the readiness of the program, including its projects and supporting infrastructure, to begin system assembly, integration and test, with acceptable risk and within cost and schedule constraints.	Changes in program scope affecting Mission Directorate requirements & constraints have been approved and documented and implemented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases; projects have successfully completed their SIRs per the Program Plan.	The hardware/ software systems, processes & procedures needed to begin system AI&T are available.	AI&T & remaining life cycle phases can be completed within budget, schedule & risk constraints.	Infrastructure and staffing for start of system AI&T are available & ready; adequate agreements exist for remaining life cycle phases.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	
KDP III[2]	**ORR**	To evaluate the readiness of the program, including its projects, ground systems, personnel, procedures and user documentation, to operate the flight system and associated ground systems in compliance with	Any residual shortfalls relative to the Mission Directorate requirements have been identified to the Mission Directorate and documented and plans are in place to resolve the	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases; projects have successfully completed their ORRs per the Program Plan.	Certification for mission operations is complete, and all systems are operationally ready.	Mission operations and sustainment can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the mission relies, for nominal and contingency operations, are in an operationally ready condition.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	Overall KDP III Expected State: Program ready for launch and early operations with acceptable risk, within Agency commitments.

KDP Review	Associated Life Cycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
		program requirements and constraints during the operations phase.	matter.						
	FRR	To evaluate the readiness of the program and its projects, ground systems, personnel, and procedures, for a safe and successful launch and flight/mission.	Any residual shortfall relative to the Mission Directorate requirements has been resolved with the Mission Directorate and documented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases; projects have successfully completed their FRRs per the Program Plan.	Certification for flight is complete, and all systems are operationally ready.	Launch & subsequent operations can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the launch & the mission rely are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks.	
Non-KDP Mission Operations Reviews	**PLAR**	To evaluate the in-flight performance of the program and its projects; to determine the program's readiness to begin the operations phase of the life cycle and to transfer responsibility to the operations organization.	Any newly discovered shortfalls relative to the Mission Directorate requirements have been identified to the Mission Directorate and documented; plans to resolve such shortfalls are in place.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases; projects have successfully completed their PLARs per the Program Plan.	All systems are operationally ready and accommodate actual flight performance; anomalies have been documented, assessed and rectified or plans to resolve them are in place.	Full routine operations & sustainment, including accommodation of actual flight performance, can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the mission relies, including accommodation of actual flight performance, are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks.	PLAR Expected State: Project ready to conduct mission operations with acceptable risk, within Agency Commitments.
	CERR	To evaluate the readiness of the program and its projects to execute a critical event during the flight operations phase of the life cycle.	Critical event requirements are complete, understandable and have been flowed down to appropriate levels for implementation.	Program and Project agreements needed to support the Critical Event are in place; projects have successfully completed their CERRs per the Program Plan.	Critical event design complies with requirements and preparations are complete, including V&V.	Planned critical event can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the Critical Event relies, including accommodation of actual flight performance, are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks applicable to the Critical Event.	Mission CERR Expected State: Project ready to conduct critical mission activity with acceptable risk.
	PFAR	To evaluate how well mission objectives were met during a human spaceflight mission; and to evaluate the status of the flight and ground	Any newly discovered shortfalls relative to the Mission Directorate requirements have been	Acquisitions, partnerships, agreements and plans are in place to support future flights; projects have successfully	All anomalies that occurred in flight are identified; actions necessary to mitigate or	Future flights and missions operations can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which future flights and missions rely, including	Risks to future flights and missions, identified as a result of actual flight performance, are	PFAR Expected State: All anomalies that occurred in flight are identified; actions necessary to

KDP Review	Associated Life Cycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
		systems, including the identification of any anomalies and their resolution.	identified to the Mission Directorate and documented; plans to resolve such shortfalls are in place.	completed their PFARs per the Program Plan.	resolve these anomalies are in place for future flights.		accommodation of actual flight performance, are in an operationally ready condition.	documented, credibly assessed, and closed or acceptable closure plans, including needed resources, are in place.	mitigate or resolve these anomalies are in place; and lessons learned identified and documented.
KDP IV to KDP n-1	**PIR**	To evaluate the program's continuing relevance to the Agency's Strategic Plan; to assess performance with respect to expectations; to determine the program's ability to execute the implementation plan with acceptable risk within cost and schedule constraints.	Program's goals, objectives and requirements remain consistent with the Agency's strategic goals; requirements are complete and properly flowed down to projects.	Program Plan and PCA are up-to-date and management infrastructure, including interfaces and partnerships, are working efficiently; program/project relationships are good; technology development plans remain adequate; and acquisition strategy is working properly.	Program's technical approach and processes are enabling project mission success; and technology development activities (if any) are enabling improved future mission performance; projects are proceeding as planned.	Credible cost/schedule estimates are supported by a documented BOE and are consistent with driving assumptions, risks, project implementation, and available funding and schedule profile.	Availability, competency and stability of staffing, essential infrastructure and additional resources other than budget are adequate for continuing program acquisitions and operations.	Significant program and project development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	Overall KDP IV to KDP n-1: Program still meets Agency needs and is continuing to meet Agency commitments as planned.
KDP n	**DR**	To evaluate the readiness of the program and its projects to conduct closeout activities, including final delivery of all remaining program/project deliverables and safe decommissioning/disposal of spaceflight systems and other program/project assets.	Decommissioning is consistent with Agency and Mission Directorate objectives and requirements; decommissioning requirements are complete, understandable and have been flowed down to appropriate levels for implementation.	Acquisitions, partnerships, agreements and plans are in place to support decommissioning, disposal, data analysis and archiving and contract closeout; projects have successfully completed their DRs per the Program Plan.	The flight hardware, and software and all associated ground systems are ready for decommissioning, including deorbit (if appropriate), and disposal.	Planned decommissioning and disposal operations can be completed within budget, schedule & risk constraints.	Infrastructure support and certified staff on which decommission-ing, deorbit and disposal rely are in an operationally ready condition.	Risks associated with decommissioning, deorbit or disposal are documented, credibly assessed and closed, or acceptable closure plans, including needed resources, are in place.	Overall KDP n Expected State: Program decommissioning is consistent with Program objectives, and program is ready for final analysis and archival of mission and science data and safe disposal of its assets.

[1] KDP 0 may be required by the Decision Authority to ensure major issues are understood and resolved prior to formal program approval at KDP I.

[2] For tightly coupled human space flight programs, a series of FRRs leads to the Agency FRR, and the Agency FRR serves as the KDP III. For tightly coupled robotic programs, the Mission Readiness Briefing (MRB) to the Mission Directorate PMC (MD PMC) serves as the KDP III. (The MRB includes summary briefings from internal reviews, the ORR, and the SMSR; project readiness status; residual risks; work remaining; launch events; and the expectation of the mission toward

meeting program-level requirements. Launch recommendations are also provided by the SRB, the Center, the program manager, OCE, OSMA, and others as applicable to formulate the Robotic Mission Directorate position for the FRR/LRR.)

Table F-3 Comprehensive Expected Maturity State Through the Project Life Cycle

NOTE: LCR entrance and success criteria in Appendix G of NPR 7123.1 and the life cycle phase and KDP requirement in NPR 7120.5 provide specifics for addressing the expected maturity state.

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
KDP A	**MCR**	To evaluate the feasibility of the proposed mission concept(s) and its fulfillment of the program's needs and objectives; to determine whether the maturity of the concept and associated planning are sufficient to begin Phase A.	The proposed Project has merit, is within the Agency/Program scope, and initial objectives and requirements are appropriate.	The Project FAD and Formulation Agreement are ready for approval and the management framework is in place; key interfaces and partnerships have been identified; and appropriate plans for Phase A are in place.	One or more technical concepts and attendant architectures that respond to mission needs are identified and appear feasible. Driving technologies, engineering development, payload, heritage hardware and software needs and risks have been identified.	Credible risk-informed options exist that fit within desired schedule and available funding profile.	Infrastructure and unique resource needs, such as special skills or rare materials, have been identified and are likely available.	The driving risks associated with each identified technical concept have been identified; approaches for managing these risks have been proposed and are adequate.	Overall KDP A Expected Maturity: Project addresses critical NASA need; proposed mission concept(s) is feasible; associated planning is sufficiently mature to begin Phase A, and the mission can likely be achieved as conceived.
KDP B	**SRR**	To evaluate whether the functional and performance requirements defined for the system are responsive to the program's requirements on the project and represent achievable capabilities.	Project requirements reflect program requirements and constraints, and are responsive to mission needs.	Project documentation is appropriately mature to support conceptual design phase and preliminary acquisition strategy is defined.	Conceptual design documented; spacecraft architecture baselined; functional and performance requirements have been defined, and the requirements will satisfy the mission.	Credible preliminary cost and schedule range estimates and associated confidence levels are supported by a documented BOE and are consistent w/ driving assumptions, risks, system requirements, design options, and available funding.	Preliminary staffing and essential infrastructure requirements have been identified and documented; preliminary sources have been identified.	Significant mission, technical, cost and schedule risks have been identified; viable mitigation strategies have been defined; a preliminary process and resources exist to effectively manage or mitigate them.	Overall KDP B Expected State: Proposed mission/system architecture is credible and responsive to program requirements and constraints including resources; and the maturity of the project's mission/system definition and associated plans is sufficient to

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
	MDR	To evaluate the credibility and responsiveness of the proposed mission/system architecture to the program requirements and constraints, including available resources; to determine whether the maturity of the project's mission/system definition and associated plans are sufficient to begin Phase B.	Mission/System requirements, design approaches, and conceptual design incorporate program requirements and constraints, and will fulfill the mission needs and mission success criteria.	Preliminary Project Plan is appropriately mature to support preliminary design phase, technology development plans are adequate, acquisition strategy is approved and initiated, and U.S. partnerships are baselined. Formulation Agreement for Phase B is ready for approval.	Driving requirements have been defined, and credible system architectures and operating concepts respond to them. Inheritance assumptions identified, verified, and assessed for risk; components and subassemblies with significant engineering development prototyped.	Credible cost/schedule estimates are supported by a documented BOE and are consistent with driving assumptions, risks, system requirements, conceptual design, and available funding and schedule profile.	Availability, competency and stability of staffing, essential infrastructure and additional resources are adequate for remaining lifecycle phases.	Significant mission, development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	begin Phase B; and the mission can likely be achieved within available resources with acceptable risk.
	SDR	To evaluate the credibility and responsiveness of the proposed mission/system architecture to the program requirements and constraints, including available resources; to determine whether the maturity of the project's mission/system definition and associated plans are sufficient to begin Phase B.	Mission/System requirements, design approaches, and conceptual design incorporate program requirements and constraints, and will fulfill the mission needs and mission success criteria.	Preliminary Project Plan is appropriately mature to support preliminary design phase, technology development plans are adequate, acquisition strategy is approved, and U.S. partnerships are baselined. Formulation Agreement for Phase B is ready for approval.	Driving requirements have been defined, and system architectures and operating concepts respond to them. Inheritance assumptions identified, verified, and assessed for risk; components and subassemblies with significant engineering development prototyped.	Credible cost/schedule estimates are supported by a documented BOE and are consistent with driving assumptions, risks, system requirements, conceptual design, and available funding and schedule profile.	Availability, competency and stability of staffing, essential infrastructure and additional resources other than budget are adequate for remaining lifecycle phases.	Significant mission, development, cost, schedule and safety risks are identified and assessed; mitigation plans have been defined; a process and resources exist to effectively manage or mitigate them.	

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
KDP C	**PDR**	To evaluate the completeness/consistency of the planning, technical & cost/schedule baselines developed during Formulation; to assess compliance of the preliminary design with applicable requirements; to determine if the project is sufficiently mature to begin Phase C.	Project requirements and preliminary designs satisfy program requirements and constraints, mission needs and mission success criteria.	Project Plan is complete; external agreements and infrastructure business case are in place; contractual instruments are in place; and execution plans for the remaining phases are appropriate.	Performance, cost, and risk trades completed; preliminary design satisfactorily meets requirements and constraints with acceptable risk; subsystem interfaces defined and evaluated for complexity and risk; assemblies with moderate to significant engineering development prototyped.	The integrated cost/schedule baseline has a sound basis and is consistent with driving assumptions; reflects risks; is fully supported by a documented BOE; fits within the available funding and schedule profile; and cost/schedule management tools/ processes are in place.	Adequate agreements exist for staffing, essential infrastructure and additional resources, as appropriate, for remaining lifecycle phases.	Mission, development and safety risks are addressed in designs and operating concepts; a process and resources exist to effectively manage or mitigate them.	Overall KDP C Expected Maturity: Project's planning, technical, cost and schedule baselines developed during Formulation are complete and consistent; the preliminary design complies with its requirements; the project is sufficiently mature to begin Phase C; and the cost and schedule are adequate to enable mission success with acceptable risk.
KDP D	**CDR**	To evaluate the integrity of the project design and its ability to meet mission requirements, with appropriate margins and acceptable risk, within defined project constraints, including available resources; to determine if the design is appropriately mature to continue with the final design and fabrication phase.	Changes in project scope affecting program requirements & constraints have been approved and documented and have been or will be implemented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining life cycle phases.	Detailed project design satisfactorily meets requirements and constraints with acceptable risk.	Driving ground rules and assumptions are realized; adequate technical and programmatic margins and resources exist to complete the remaining life cycle phases of the project within budget, schedule and risk constraints.	Infrastructure and staffing for final design and fabrication are available/ready; adequate agreements exist for remaining life cycle phases.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	Overall KDP D Expected Maturity: Project is still on plan; the risk is commensurate with the project's payload classification; and the project is ready for AI&T with acceptable risk within Agency Baseline Commitment.

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
	PRR	To evaluate the readiness of system developer(s) to produce the required number of systems within defined project constraints, for projects developing multiple similar flight or ground support systems; to evaluate the degree to which the production plans meet the system's operational support requirements.	Changes in project scope affecting program requirements & constraints have been approved and documented and have been implemented in the design.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases.	Project design is sufficiently mature to proceed with full-scale production and is consistent with requirements & constraints.	Production & remaining lifecycle phases can be completed within budget, schedule & risk constraints.	Infrastructure and staffing for conducting production are available & ready; adequate agreements exist for remaining lifecycle phases.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	
	SIR	To evaluate the readiness of the project and associated supporting infrastructure to begin system assembly, integration and test; to evaluate whether the remaining project development can be completed within available resources; to determine if the project is sufficiently mature to begin Phase D.	Changes in project scope affecting program requirements and constraints have been approved, documented and implemented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases.	The hardware/ software systems, processes & procedures needed to begin system AI&T are available.	AI&T & remaining lifecycle phases can be completed within budget, schedule & risk constraints.	Infrastructure and staffing for start of system AI&T are available & ready; adequate agreements exist for remaining lifecycle phases.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
KDP E*	ORR	To evaluate the readiness of the project to operate the flight system and associated ground system(s), in compliance with defined project requirements and constraints, during the operations/sustainment phase of the project life cycle.	Any residual shortfalls relative to the program requirements have been identified to the program and documented and plans are in place to resolve the matter.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases.	Certification for mission operations is complete, and all systems are operationally ready.	Mission operations and sustainment can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the mission relies, for nominal and contingency operations, are in an operationally ready condition.	Accepted risks are documented and credibly assessed; a process and resources exist to effectively manage or mitigate remaining open risks.	Overall KDP E Expected State: Project and all supporting systems are ready for safe, successful launch/early operations with acceptable risk, w/in Agency Baseline Commitment.
	MRR/FRR	To evaluate the readiness of the project and all project and supporting systems for a safe and successful launch and flight/mission.	Any residual shortfall relative to the program requirements has been resolved with the program and documented.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases.	Certification for flight is complete, and all systems are operationally ready.	Launch & subsequent operations can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the launch & the mission rely are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks.	
NA	PLAR	To evaluate in-flight performance of the flight system early in the mission and determine whether the project is sufficiently prepared to begin phase E.	Any newly discovered shortfalls relative to the program requirements have been identified to the program and documented; plans to resolve such shortfalls are in place.	Acquisitions, partnerships, agreements and plans are in place to complete the remaining phases.	All systems are operationally ready and accommodate actual flight performance; anomalies have been documented, assessed and rectified or plans to resolve them are in place.	Full routine operations & sustainment, including accommodation of actual flight performance, can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the mission relies, including accommodation of actual flight performance, are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks.	PLAR Expected State: Project ready to conduct mission operations with acceptable risk, w/in Agency B/L Commitment.
	CERR	To evaluate the readiness of the project and the flight system for execution of a critical event during the flight operations phase of the lifecycle.	Critical event requirements are complete, understandable and have been flowed down to appropriate levels for implementation.	Project agreements needed to support the Critical Event are in place.	Critical event design complies with requirements and preparations are complete, including V&V.	Planned critical event can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which the Critical Event relies, including accommodation of actual flight performance, are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks applicable to the Critical Event.	Mission CERR Expected State: Project ready to conduct critical mission activity with acceptable risk.

KDP Review	Associated Lifecycle Review	LCR Objectives	Expected Maturity State by Review Criteria						Overall Expected Maturity State at KDP
			Agency Strategic Goals	Management Approach	Technical Approach	Budget and Schedule	Resources Other Than Budget	Risk Management	
	PFAR	To evaluate how well mission objectives were met during a human spaceflight mission; to evaluate the status of the returned vehicle.	Any newly discovered shortfalls relative to the program requirements have been identified to the program and documented; plans to resolve such shortfalls are in place.	Acquisitions, partnerships, agreements and plans are in place to support remaining flights.	All anomalies that occurred in flight are identified; actions necessary to mitigate or resolve these anomalies are in place.	Continuing flights and missions operations can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff on which continuing flights and missions rely, including accommodation of actual flight performance, are in an operationally ready condition.	Risks to future flights and missions, identified as a result of actual flight performance, are documented, credibly assessed, and closed or acceptable closure plans, including needed resources, are in place.	PFAR Expected State: All anomalies that occurred in flight are identified; actions necessary to mitigate or resolve these anomalies are in place; and lessons learned identified and documented.
KDP F	**DR**	To evaluate the readiness of the project to conduct closeout activities, including final delivery of all remaining project deliverables and safe decommissioning of spaceflight systems and other project assets; to determine if the project is appropriately prepared to begin Phase F.	Decommissioning is consistent with Agency and Program objectives and requirements; decommissioning requirements are complete, understandable and have been flowed down to appropriate levels for implementation.	Acquisitions, partnerships, agreements and plans are in place to support decommissioning.	The flight hardware, and software and all associated ground systems are ready for decommissioning.	Planned decommissioning can be completed within budget, schedule & risk constraints.	Infrastructure support and certified staff on which decommissioning rely are in an operationally ready condition.	Risks associated with decommissioning are documented, credibly assessed and closed, or acceptable closure plans, including needed resources, are in place.	Overall KDP F Expected State: Project decommissioning is consistent with program objectives, and project is ready for safe decommissioning of its assets and closeout of activities, including final delivery of all remaining project deliverables and disposal of its assets.
Non-KDP Disposal Readiness Review	**DRR**	To evaluate the readiness of the project and the flight system for execution of the spacecraft disposal event.	Disposal event requirements are complete, understandable and have been flowed down to appropriate levels for implementation.	Project agreements needed to support the Disposal event are in place.	Disposal event design complies with requirements and preparations are complete, including V&V.	Planned Disposal event can be conducted within budget, schedule & risk constraints.	Infrastructure support and certified staff, on which the Disposal event relies, including accommodation of actual flight performance, are in an operationally ready condition.	Accepted risks are documented, credibly assessed and communicated; acceptable closure plans, including needed resources, exist for any remaining open risks applicable to the Disposal Event.	Mission DRR Expected State: Project ready to conduct disposal activity with acceptable risk.

*For human space flight a series of MRR/FRRs leads to the Agency MRR/FRR, which serves as the KDP E. For robotic missions, the Mission Readiness Briefing (MRB) to the Mission Directorate PMC (MD PMC) serves as the KDP E. (The MRB includes summary briefings from internal reviews, the ORR, and the SMSR; project readiness status; residual risks; work remaining; launch events; and the expectation of the mission toward meeting program-level requirements. Launch

recommendations are also provided by the SRB, the Center, the program manager, OCE, OSMA, and others as applicable to formulate the Robotic Mission Directorate position for the FRR/LRR.)

Table F-4 Objectives for Other Reviews

Review Name	Review Objective
System Acceptance Review (SAR)	To evaluate whether a specific end item is sufficiently mature to be shipped from the supplier to its designated operational facility or launch site.
Safety and Mission Success Review (SMSR)	To prepare Agency safety and engineering management to participate in program final readiness reviews preceding flights or launches, including experimental/test launch vehicles or other reviews as determined by the Chief, Safety and Mission Assurance. The SMSR provides the knowledge, visibility, and understanding necessary for senior safety and engineering management to either concur or nonconcur in program decisions to proceed with a launch or significant flight activity.
Launch Readiness Review (LRR)	To evaluate the readiness for launch of a program/project, and ground hardware and software systems.

Appendix G. Project Decommissioning

G-1 All projects will eventually cease as a natural evolution of completing their mission objectives. When this occurs, the Mission Directorate, program, and project need to be sure that all the products produced by the project (e.g., spacecraft, ground systems, test beds, spares, science data, operational data, returned samples, etc.) are properly dispositioned and that all project activities (e.g., contracts, financial obligations, etc.) are properly closed out. The project develops a Decommissioning Plan to cover all activities necessary to close the project out and conducts a Decommissioning Review in preparation for final approval to decommission by the Decision Authority (or designee) at KDP F.

G2. The decommissioning of a project with operating spacecraft requires the project to ensure the safe and adequate disposal of the spacecraft. Figure G-1 provides an overview of the disposal of a spacecraft, the various documents that are produced as part of this, and the order and timing of major activities and document deliveries.

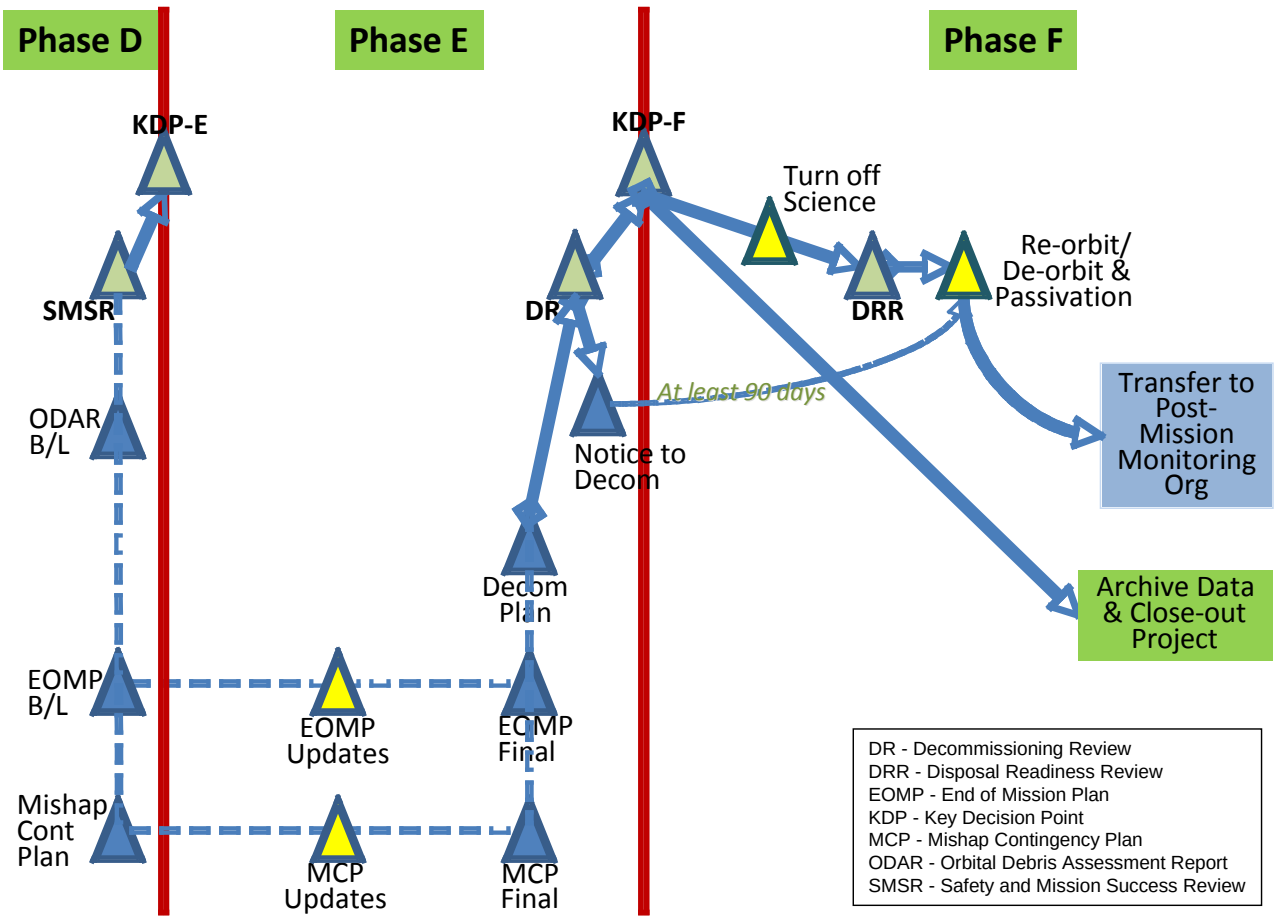


Figure G-1 Spacecraft Disposal Process Flow

G3 The actual disposal of the spacecraft (re-orbit, de-orbit and passivation) need to meet Agency orbital debris requirements and is a critical event. As a result, this event requires a Disposal Readiness Review (DRR). This review evaluates the readiness of the project and the flight system for execution of the spacecraft disposal event (See Table F-3.) In many cases, such as small spacecraft, the decommissioning and disposal will occur relatively closely together. In these instances, the Decommissioning and Disposal Readiness Reviews may be conducted together.

G4 Decommissioning and Phase F end when the project funding is finally terminated[26].

G5 Decommissioning Plan

The Decommissioning Plan is prepared by the project manager and approved by the program manager; Center Director; Chief, SMA (via Orbital Debris Program Manager); the MDAA; and the Decision Authority, if not the MDAA. This plan is approved at KDP F.

The Decommissioning Plan contains the following:

- Updated End of Mission Plan (EOMP), including method and location of disposal, planned status of spacecraft after disposal, schedule, safety and environmental considerations;
- Updated Mishap Contingency Plan and pre-defined contingency/mishap scenarios;
- Approach and plans for notifying stakeholders and customers of the intent to decommission the project and spacecraft, per NPD 8010.3;
- Approach and plans for archiving science, operations, and engineering data (methods, media, locations, etc.);
- Approach and plans for communications security;
- Approach and plans for disposition of all hardware, software, and facilities remaining on the ground;
- Approach and plans for closing out contracts, financial obligations, and project infrastructure and transferring project personnel; and

[26] For SMD projects, project funding covers archival of the science data produced by the spacecraft (and the ancillary data for its interpretation) prior to project termination. This ensures that the science community will have access to this data for follow-on science research and data analysis.

Chapter 5. Approach and plans for long-term monitoring of spacecraft remaining on orbit.

Appendix H. References

H.1 NASA Policy Directives and NASA Procedural Requirements

a. NPD 1440.6, *NASA Records Management*.

b. NPD 1600.2, *NASA Security Policy*.

c. NPD 2200.1, *Management of NASA Scientific and Technical Information.*

d. NPD 7120.4, *NASA Engineering and Program/Project Management Policy*.

e. NPD 7500.1, *Program and Project Logistics Policy*.

f. NPD 7500.2, *NASA Innovative Partnerships Program*.

g. NPD 8010.3, *Notification of Intent to Decommission or Terminate Operating Space Systems and Terminate Missions*.

h. NPD 8020.7, *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft*.

i. NPD 8700.1, *NASA Policy for Safety and Mission Success*.

j. NPD 8720.1B, *NASA Reliability and Maintainability (R&M) Program Policy*.

k. NPD 8730.5, *NASA Quality Assurance Program Policy*.

l. NPD 8900.5, *NASA Health and Medical Policy for Human Space Exploration*.

m. NPR 1040.1, *NASA Continuity of Operations (COOP) Planning Procedural Requirements*.

n. NPR 1441.1, *NASA Records Retention Schedules.*

o. NPR 1600.1, *NASA Security Program Procedural Requirements*.

p. NPR 2190.1, *NASA Export Control Program*.

q. NPR 2200.2, *Requirements for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information.*

r. NPR 2810.1, *Security of Information Technology*.

s. NPR 2830.1, *NASA Enterprise Architecture Procedures*.

t. NPR 7120.6, *Lessons Learned Process*.

u. NPR 7120.8, *NASA Research and Technology Program and Project Management Requirements*.

v. NPR 7120.9, *NASA Product Data and Life Cycle Management (PDLM) for Flight Programs and Projects*.

w. NPR 7120.10, *Technical Standards for NASA Programs and Projects*.

x. NPR 7500.1, *NASA Technology Commercialization Process*.

y. NPR 8000.4, *Agency Risk Management Procedural Requirements*.

z. NPR 8020.12, *Planetary Protection Provisions for Robotic Extraterrestrial Missions.*

aa. NPR 8580.1, *Implementing The National Environmental Policy Act And Executive Order 12114*.

bb. NPR 8705.2, *Human-Rating Requirements for Space Systems.*

cc. NPR 8705.4, *Risk Classification for NASA Payloads*.

dd. NPR 8705.6, *Safety and Mission Assurance (SMA) Audits, Reviews, and Assessments*.

ee. NPR 8715.3, *NASA General Safety Program Requirements*.

ff. NPR 8715.5, *Range Flight Safety Program*.

gg. NPR 8715.6, *NASA Procedural Requirements for Limiting Orbital Debris*.

hh. NPR 8735.2, *Management of Government Quality Assurance Functions for NASA Contracts.*

ii. NPR 8900.1, *Health and Medical Requirements for Human Space Exploration*.

jj. NPR 9250.1, *Property, Plant, and Equipment and Operating Materials and Supplies*.

kk. NPR 9420.1, *Budget Formulation*.

ll. NPR 9470.1, *Budget Execution*.

mm. NASA-STD-0005, *NASA Configuration Management (CM) Standard*.

nn. NASA-STD-8709.20, *Management of Safety and Mission Assurance Technical Authority (SMA TA) Requirements.*

oo. NASA-STD-8719.13, *NASA Software Safety Standard.*

pp. NASA-STD-8719.14, *Process for Limiting Orbital Debris*.

qq. NASA-STD-8739.8, *Software Assurance Standard.*

rr. *NASA Standing Review Board Handbook*.

ss. *NASA Space Flight Program and Project Management Handbook.*

tt. SP-2007-6105, *NASA Systems Engineering Handbook.*

uu. *Program and Project Management Handbook.*

vv. *Schedule Management Handbook.*

ww. *Work Breakdown Structure Handbook.*

xx. *NASA Federal Acquisition Regulation (FAR) Supplement.*

H.2 Non-NASA Standards

a. Air Force Space Command Manual 91-710, *Range Safety User Requirements Manual Volume 3 - Launch Vehicles, Payloads, and Ground Support Systems Requirements.*

b. ANSI/EIA-748 , Earned Value Management Systems.

c. DI-MGMT-81466, Contract Performance Report.

d. DI-MGMT-81650, Integrated Master Schedule.

H.3 Related References

a. Reports

(1) Columbia Accident Investigation Board Report, Volume 1, August 2003. (Available at http://www.nasa.gov/columbia/home/CAIB_Vol1.html)

b. NASA Special Publications and Similar Documents

(1) NASA Project Management Competency Model.

(2) The Federal Acquisition Certification for Program/Project Managers Center Implementation Guidelines.

(3) IBR Toolkit.

(4) NASA EVM System Description.

c. Web Sites

(1) *NASA Cost Estimating Handbook*, http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html

(2) NASA Technical Standards Program Web site, http://standards.nasa.gov

(3) NASA Engineering Network Web site, https://nen.nasa.gov/web/pm

(4) NASA Business Case Guide for Facilities Projects, http://www.hq.nasa.gov/office/codej/codejx/codejx.html

(5) NASA Online Directives Information System (NODIS), http://nodis3.gsfc.nasa.gov

(6) NASA forms Web site, http://server-mpo.arc.nasa.gov/Services/NEFS/

(7) NASA EVM Web site, http://evm.nasa.gov